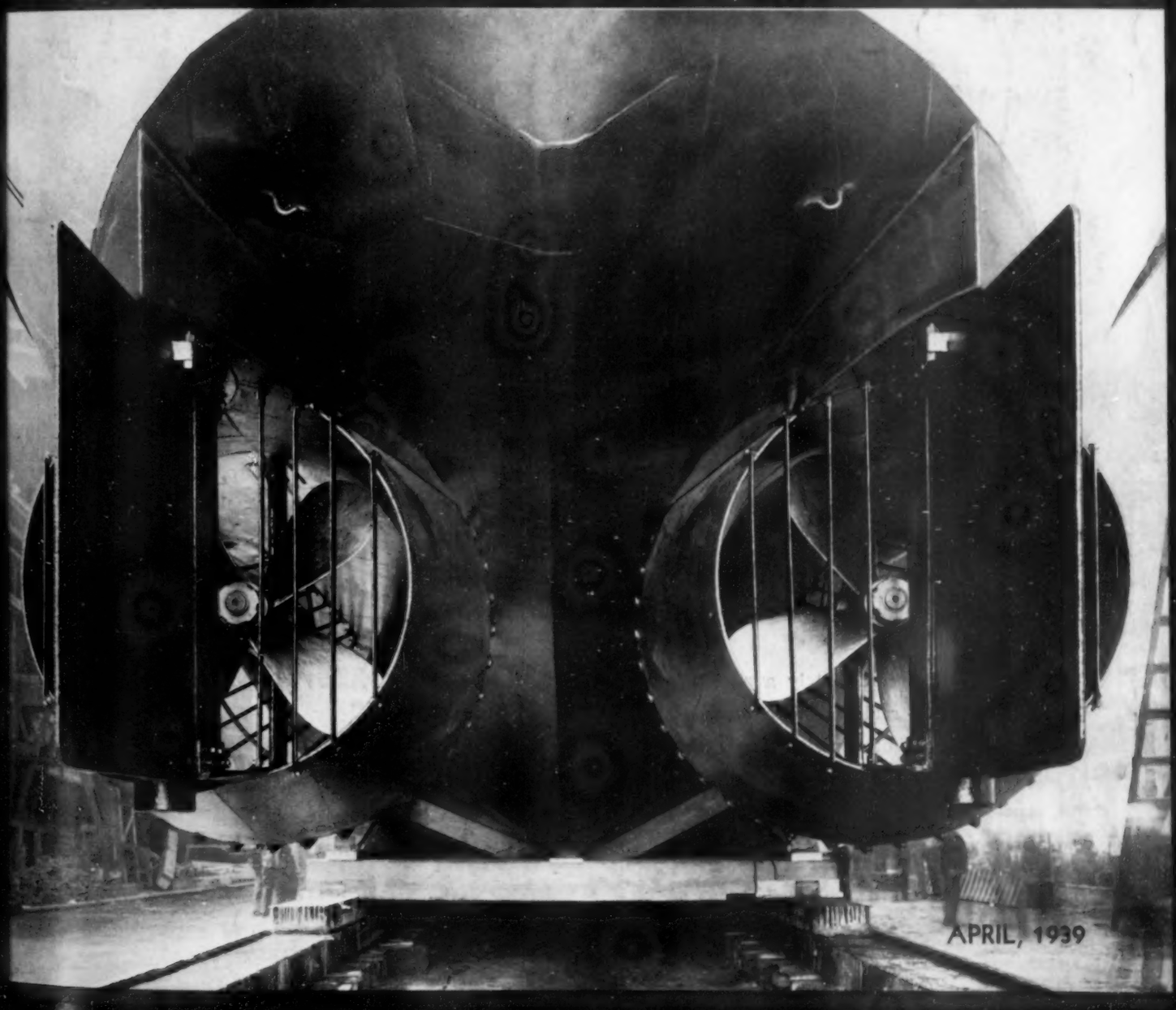
The Welding Journal



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Published for the Advancement of the Science and Art of Welding

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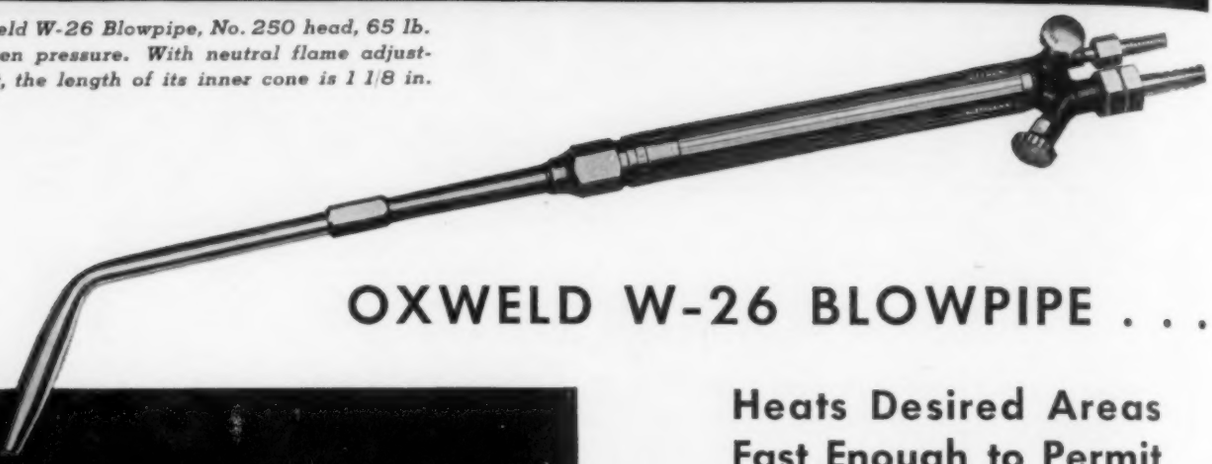

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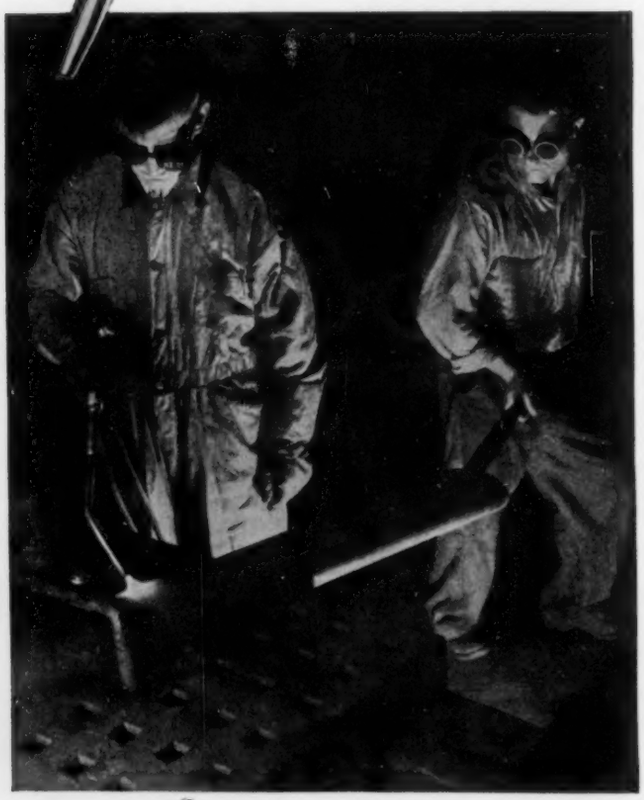

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Welding Journal

VOLUME 18, No. 4 APRIL 1939

MANUFACTURE of COMPOSITE Metals by Carbon Arc Welding*

By ROBERT E. KINKEAD†

PRACTICALLY since man first began to use materials, he has employed them in certain combinations to accomplish desired results. In his first shelter, he used crude logs or poles for supports, dried mud and grass for the walls and a similar composition for the roof. Later, certain refinements appeared in the form of hewn or shaped timbers for frame work, planed lumber for walls and roof, etc.

Today, the use of composite materials is reflected in many and varied forms. Galvanized wire, pipe and sheets combine the strength and low-cost of steel with the corrosion resistance of zinc. Steel is coated with glass, rubber, copper, brass, paint lacquer, alloys for hard facing, etc.—all for the purpose of increasing utility and serviceability.

The actuating motive in use of composite metals is usually one of reducing the initial cost or the cost of use. Thus, copper clad steel wire for railway signal bonds lasts ten to twenty times as long as pure copper bonds of the same initial cost, on account of the resistance of the steel core to destruction by vibration. Nickel clad steel used for making vessels which handle food products costs about one half as much as solid nickel plate for the same purpose. The composite has greater strength and, since only one side can possibly come in contact with food, serves the purpose exactly as well as solid nickel plate. No one will knowingly pay $1000 for solid nickel plate when $500 spent for nickel clad steel will do the job equally well.

The chromium nickel alloys which have been developed in recent years have found many uses. The 18% chromium with 8% nickel specification with additions of possibly molybdenum, columbium or titanium, comprise the most popular group of stainless steels at the present time. The use of these almost noble metals is inhibited by the high price for which they must be sold. At $580 per ton base price, 18–8 costs roughly 14 times as much as carbon steel. For about half the known uses, low carbon steel with a properly applied cladding of 18–8 would serve the purpose just as well as solid stainless. The price might be half as much for the composite material as for the solid stainless. With a 1937 production of 75,851 tons of finished stainless and heat resisting alloys, having an aggregate value of about $60,000,000, the desirability of composite material is obvious.

While the advantages of composites of low carbon steel and very expensive metals is striking, the economies of composite metals are by no means restricted by such cases. Thus, one of the serious problems which has been encountered in the design and construction of welded steel machinery has been a lack of low cost composite metals. Machined surfaces on low and medium carbon steel are expensive as compared with machine work on steel having 0.40% carbon, and it is a fact that lubrication is difficult and wear unsatisfactory for rapidly moving parts made of low carbon steel. Building up such surfaces by manual or even automatic arc welding machines is, in many cases, prohibitively expensive. On the other hand, if the parts are made of steel having the machining and wearing qualities of 0.40% carbon or more, it becomes necessary to preheat the machinery part in the welding operation to prevent it from cooling rapidly and cracking.

A notable example of this limitation in the building of welded steel machinery parts is the problem of making welded steel gear blanks. The rim needs to be 0.40% carbon steel or above to have the gear tooth cutting operation successful. The remainder of the gear blank may be medium carbon steel. The job of handling the welded type of gear blank and welding it while hot is so difficult that most manufacturers prefer to buy cast

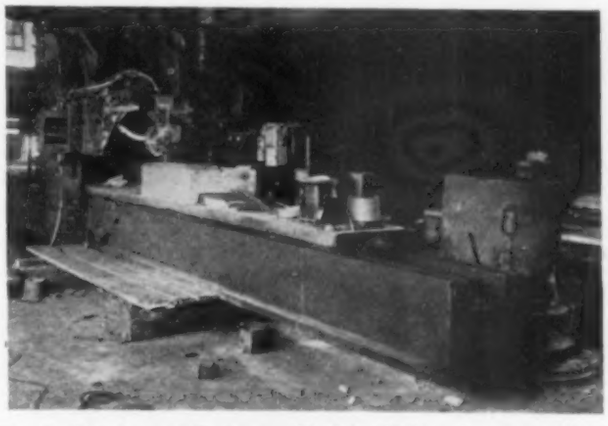


Fig. 1—Experimental Equipment Used for Making Composite Metals by Carbon Arc Welding

* The author of this paper received the third Grand Award, $8852.94, of the $200,000 Program sponsored by the James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, in which savings of $1,600,000,000 were shown available to industry by wider application of arc welding.

† Consulting Engineer, Welding, Cleveland, Ohio.

Fig. 2

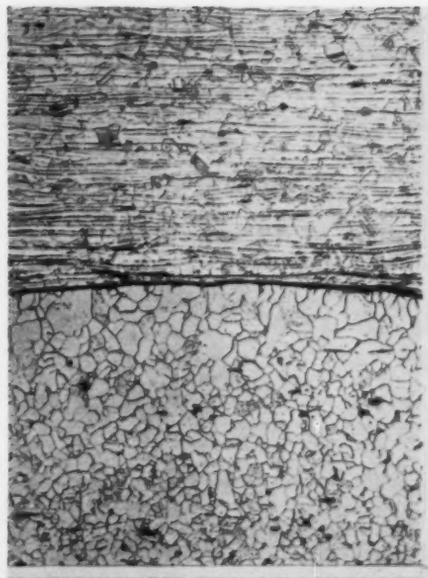


Fig. 3

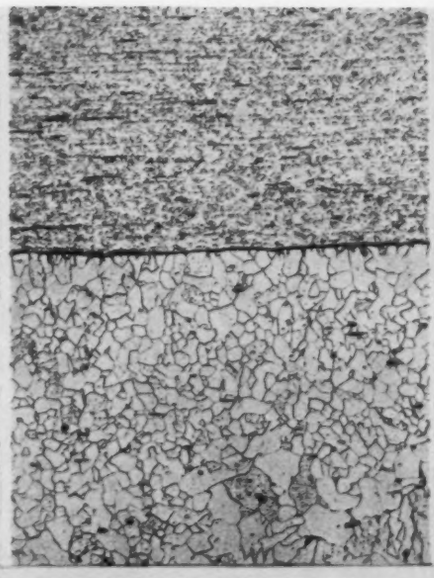
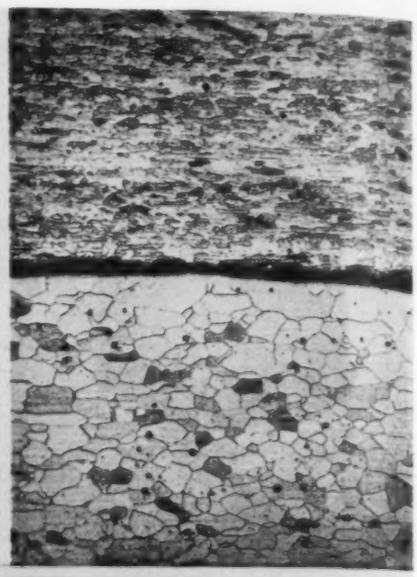
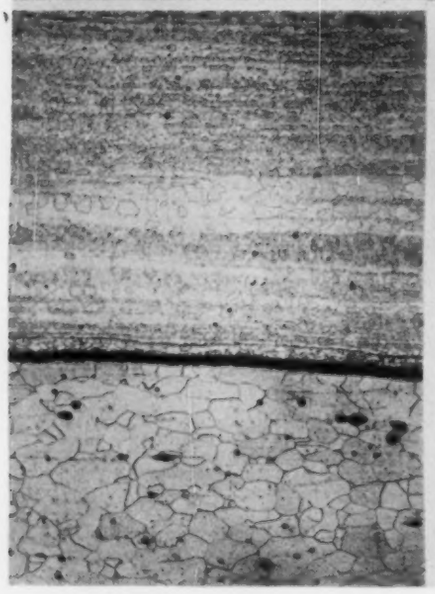


Fig. 4





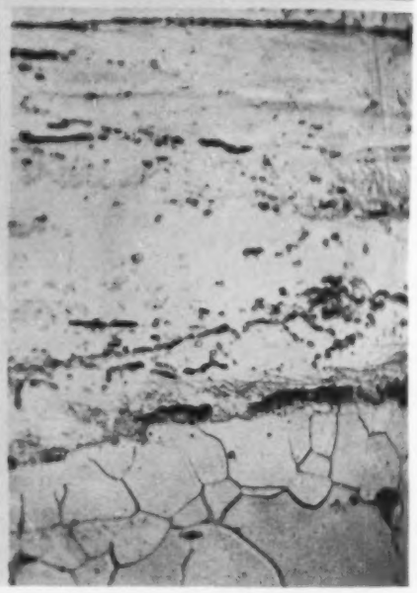


Fig. 5

Fig. 2—Completely Processed Stainless Clad Steel, 14 Gage Sheets. Structure of 18-8 Mo Clad Sheet. In the Photograph the Dark Bond May Appear to Be a Separation of the Two Metals, but Such Is Not the Case. X 100. Etchants: Electrolytic Chromic Acid and 5% Nital

Fig. 3—Completely Processed Stainless Clad Steel, 14 Gage Sheets. Structure of 18-8 Cb Clad Sheet. X 100. Etchants: Electrolytic Chromic Acid and 5% Nital

Fig. 4—Completely Processed Stainless Clad Steel, 14 Gage Sheets. Micro-Structure of 12% Chromium Clad Steel Sheet, Showing Clad Bond and Base Metal. The Clad Structure (Top) Consists of Ferrite and Carbides and Is Typical of Regular 12% Chromium. The Structure of the Plain Carbon Base Metal Is Normal. The Bond Consists of Small Ferrite Grains with a Large Number of Carbides. X 100. Etchants: Electrolytic Chromic Acid and 5% Nital

Fig. 6

Fig. 5—Completely Processed Stainless Clad Steel, 14 Gage Sheets. Micro-Structure of 17% Chromium Clad Steel Sheet. The Clad Consists of Ferrite and Carbides, and with the Exception of the Laminated Condition, Is Comparable to Solid 17% Chromium. The Structure of the Base Metal (at Bottom) Is Normal. The Dark Etching Bond Is Similar to the Bond of Plate 3 and Is Composed of Ferrite and a Large Number of Carbides. Etchants: Electrolytic Chromic Acid and 5% Nital

Fig. 7

Fig. 6—Completely Processed 17% Chromium Clad Steel, 14 Gage Sheet. Structure of Clad (Top) Is Typical of the Structure of 17% Chromium. The Bond Is Structureless. The Grain Growth in the Open-Hearth Steel Was Confined to the Zone Next to the Bond. X 100. Etchants: Electrolytic Chromic Acid and 5% Nital

Fig. 7—Micro-Structure of Semi-Processed 18-8 Clad Steel 1/2 Plate Hot Rolled. Showing in Greater Detail the Structure Where the Two Metals Join. X 750. Etchants: Electrolytic Chromic Acid and 5% Nital

steel blanks. If a line of bar stock were available from the steel mills with say 50% of the thickness 0.40 to 0.50% carbon and the remainder in the 0.15 to 0.25% range, most manufacturers would make their own gear blanks by welding. The rim would be formed hot with the higher carbon on the outside. The assembly of the welded steel gear blank could then be made by welding on the low carbon side without preheating.

The above described composite would also be useful in welded steel machinery for guides, ways on planers and in many other places on the machine where a surface is machined and subjected to wear.

The Need for a New Method of Making Composite Metal.—When composite metals are to be fabricated, their usefulness is always a function of the quality of the bond between the component parts of the composite.

Unless the bond is perfect, the metals separate in fabrication. Thus, plating alone is used *after* the metal has been formed and all of the cold work completed on it. The bond is one of adhesion, not cohesion as in a weld. To get cohesion in a plated composite it must be hot rolled.

A further necessity is that the composite have a uniform and entirely complete bond between the components. Thus, even though 98% of the area of contact between the components is perfectly bonded by cohesion, but the remaining 2% of area is held only by adhesion, the composite will be commercially unacceptable. Failure will occur when the composite is formed with the surface component in compression, or the defects will show up as blistering in service where the composite material is subjected to heat. A skillet made of a composite of carbon steel and stainless for the inside serves the purpose well if the bond is perfect and complete. But if the bond is not perfect and complete the stainless will blister because it has about two and one-half times the coefficient of expansion and contraction of carbon steel. The point is well illustrated also in the case of stainless lined oil refinery vessels. While they give a satisfactory life in consideration of their cost, they fail by blistering between welds long before the lining itself is appreciably corroded. No low cost composite metal meeting these requirements has heretofore been available, in spite of these obvious needs.

The requirement that the bond in composite metals be good for 100% the area of contact is the first and most important necessity. The second need is that the composite shall be made by low cost methods so that its manufacture and sale may be carried out to yield a profit to the maker.

Making Composite Metals in the Steel Producing Plant.—The necessity for making the composites at low cost immediately indicates that the metal should be operated on as early in the basic process of manufacture as possible. Steel is made, rolled and processed by the most expensive machinery in order to handle it on a mass production basis and produce it at a cost which promotes its universal use. The conclusion cannot be escaped that the time to make the composite is while the metal is in the ingot or slab or, in some cases, the billet form. If the metal is made composite here, it goes through all of the subsequent rolling and processing equipment which can handle it at high speed and low costs.

The contrasting cases of making nickel clad steel and making electroplated copper clad steel, which is subsequently hot rolled, illustrates the point. Nickel clad steel is made by rolling together solid nickel slabs and steel slabs. A one inch thick nickel slab may be rolled onto a nine inch thick steel slab. Thus, by working on one square foot of steel 10 inches thick, 80 square feet of 10% nickel clad steel is obtained when it is rolled down to 1/8 inch thickness. On the other hand, plating 0.013 inch of copper on 0.125 inch thick steel for subsequent hot rolling would be entirely prohibitive in cost, because 80 times the area would have to be operated on.

The process and equipment hereinafter described is designed to work on ingots, slabs or billets in the steel producing plant and be further processed by existing equipment.

Composite Metals by Carbon Arc Welding.‡—In the steel making process, the metal in the ingot stage represents the lowest cost of the metal in the solid state. Value is added by all of the subsequent operations. It is most desirable, therefore, to make the composite when the metal is in the ingot stage, particularly by the process hereinafter described. Considering an ingot of low carbon steel, all that is needed to make it a composite is to add the necessary alloying elements to the metal on the surface to get the desired chemical analysis. This may be readily accomplished by carbon arc welding. It would be a round about and relatively expensive process to coat the surface of the ingot with the alloy desired in the form of a metal wire or rod using the metal electrode arc welding process. Thus, in the making of a composite having an 18–8 stainless surface, in the case of carbon arc welding, it is only necessary to add ferrochrome and nickel with an alloying element cost of about 8¢ per pound of 18–8 produced. Making an 18–8 surface by depositing 18–8 rod and metal arc welding would im-

Fig. 8—Micro-Structures of Completely Processed 18–8 Clad Steel, 14 Gage Sheets. Structure of Clad Bond and Base Metal. Heavy Grain Boundaries in Clad Near Bond, Indicate Carbide Precipitation. Structure of Base Metal Is Normal. X 100

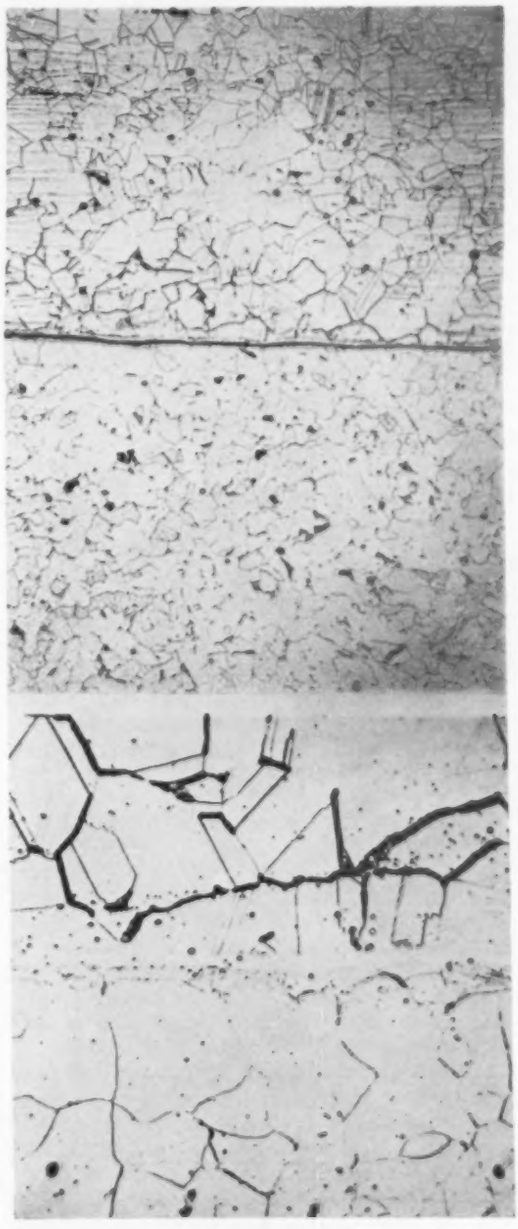


Fig. 9—Micro-Structures of Completely Processed 18–8 Clad Steel, 14 Gage Sheets. Showing in Greater Detail the Bond Structure. X 500

‡ Patents are pending on process described.

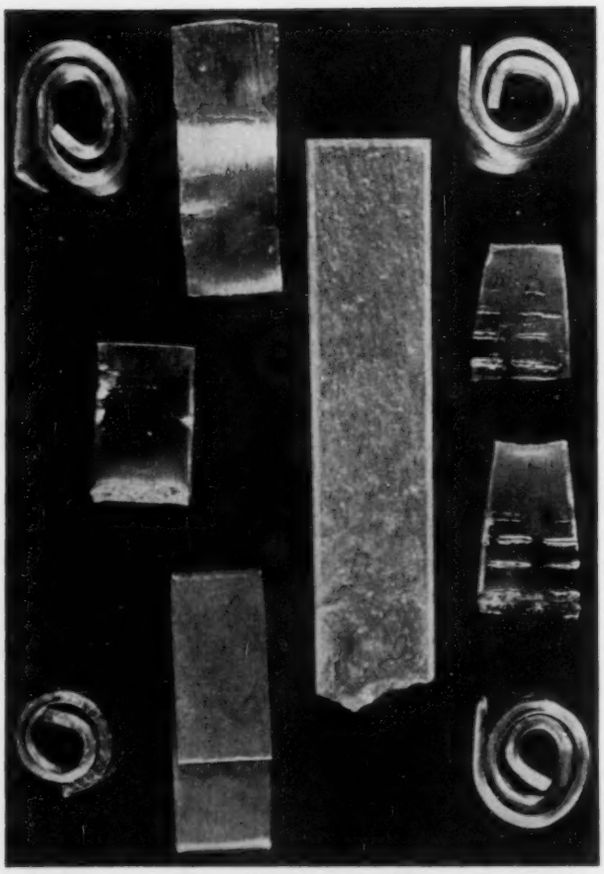


Fig. 10—Samples of Composite Metal Made of Low Carbon Steel and 18–8 Deformed to Show That Bond Does Not Fail Under Any Conditions. Center Flat Piece Shows Non-Planer Character of Bond

mediately involve a cost of 50 to 60¢ per pound for the stainless steel rod. In the latter case, the alloy is made and reduced to rod form suitable for welding and heavy costs are involved. In the carbon arc method, the stainless steel is made directly on the ingot using the ingot metal itself as the base.

Experimental production of composite metals by carbon arc welding has been carried out over a period of two years. To avoid excessive cost of experimental apparatus, work has been done on slabs where the depth to which the surface alloying extended could be from $^1/_2$ inch to 1 inch. Large current supplying apparatus would have been required on thick ingots for a 20% depth of surface alloy. Such apparatus was not available for experimental purposes.

Figure 1 shows the experimental equipment used. A Tornado Carbon arc head is mounted on the tool carriage of a planer. Motor and cam arrangement is provided to oscilliate the head transversely to the direction of travel of the planer bed. The cam was designed empirically to give uniform distribution of the heat in operation so that uniform depth of penetration of the alloy was the result. The cam turned out to be asymmetric due to factors which could not be calculated. Many slabs were sectioned and the penetration measured and cam corrected accordingly. Current for the arc circuit was obtained from an 800 ampere welder for thin alloy surfaces and from a special motor-generator for currents up to 3000 amperes for thick alloy surfaces.

The furnace mounted on the planer bed is provided for preheating the slab and working on it with the arc while it is hot. Adjustable speed is provided on the planer bed.

The operation for this experimental making of composite metals may be briefly described, as follows:

The slab (0.04 to 0.06% carbon, 0.20 to 0.30% manganese) is put in the furnace and suitable ground connection made to it. The alloy is applied in shallow pans. These pans are very thin low carbon steel and are melted in the process. The bottom of the pan is covered with the correct amount of alloy. In the case of making 18–8, ferrochrome of the low carbon specification broken down to 10 mesh is used, together with nickel shot. Molybdenum, columbium, manganese may be added, depending on the grade of alloy wanted. The pan is then completely filled with slag, the height of the pan being designed so that when level full the right amount is present. This slag is composed of waste slag from an electric furnace in which 18–8 has been made together with sand and calcium fluoride. The slab is now heated in the furnace with the alloy and slag in the proper location. An excess of slag is applied around the margin of the pans to keep the metal from flowing off the slab when the operation is in progress.

The slab is heated to a temperature of about 800° C. as determined by pyrometer with the top of the furnace covered. The carbon arc welding operation is started after the cover has been partially removed and proceeds from one end of the alloyed surface to the other. A 6-inch oscillation of the arc and 20 inches travel was found suitable for obtaining the specimens required for testing the composite material throughout the complete rolling and processing and final testing. On 2 inch thick slabs 1800 amperes, 45 to 50 volts across the arc, 1.6 inches per minute planer bed travel were found suitable. Under these conditions, the metal alloyed would stay molten from $^3/_4$ to the total length of the travel, depending on the alloy being made. This was found to be a very important matter. After sectioning many alloyed slabs, it was shown conclusively that no failure of obtaining a perfect bond, over 100% of the area of contact, was ever encountered without striking evidence being visible on the surface.

Thus, the process was developed to the point at which there could never be any uncertainty relative to this most important consideration. Any unusual condition resulting in the presence of blow-holes or slag inclusions is immediately evident on the surface of the alloyed metal. This advantageous set of conditions would be predicted by any one who had had experience with carbon arc welding under the conditions which this alloying is done.

After the alloying operation, the slab is removed from the furnace and cooled. The slag is easily removed when the slab is cool. The subsequent operations in the making of the finished product occur about as follows:

The surface of the alloy is given a light grind to remove scale and uneven spots. The slab is then put in the heating furnace preparatory to rolling. In the case of the test slabs, the hot rolling was first done to reduce and spread the alloy. The long dimension went into the rolls parallel to the axis of the rolls. Rolling was done in two stages—first, down to about $^1/_2$ inch thickness and allowed to cool. Later the material was hot rolled on down to $^3/_8$ inch, $^3/_{16}$ inch, 14 gage. The material was then annealed and pickled, and in some cases cold reduced down as low as 20 gage.

No serious difficulty was encountered in rolling operations. Some special handling is required on account of the unavoidable tendency to curl due to difference in contraction coefficient of the two metals forming the composite.

Results of Chemical Analysis.—There is given herewith typical chemical analysis of the alloy component of

the composites made by carbon arc welding by the methods described. It is fairly obvious that the process is controllable to produce alloys in the form of composites within predetermined specifications. While the experimental apparatus was crude and difficult to control, every cause of variation was explored and the difficulties corrected in the design of the commercial equipment hereinafter described.

Table 1—Typical Analysis Data on Surface Alloyed Slabs

Analysis of Surface			20% Cladding 2-Inch Slab			
18–8				Speed In.	Current	Arc
C	Cr	Ni	Preheat	per Min.	Amp.	Voltage
0.08	17.52	8.52	800° C.	1.55	1800	44
0.08	18.60	8.23	800° C.	1.61	1800	45
0.06	18.36	8.92	800° C.	1.52	1800	49
0.07	17.6	8.07	800° C.	1.53	1800	45

Table 2—18–8 Molybdenum

C	Cr	Ni	Mo	Mn	Preheat	Speed In. per Min.	Current Amp.	Arc Voltage
0.06	18.21	9.34	2.70	1.28	800° C.	1.55	1800	49
0.06	18.20	9.34	2.40	1.16	800° C.	1.51	1800	49
0.07	19.86	10.68	3.10	1.38	800° C.	1.52	1800	45
0.08	19.22	9.41	2.60	1.90	800° C.	1.50	1800	45

Table 3—12 Cr

C	Cr	Preheat	Speed In. per Min.	Current Amp.	Arc Voltage
0.09	11.97	800° C.	1.6	1800	43
0.08	12.59	800° C.	1.6	1800	42
		17 Cr			
0.09	18.33	800° C.	1.71	1800	44
0.06	17.28	800° C.	1.7	1800	45
		26 Cr			
0.12	25.08	800° C.	1.68	1800	45
0.09	29.6	800° C.	1.71	1800	44

Physical Nature of the Bond.—There are reproduced herewith photomicrographs showing the nature of the bond between low carbon steel and 18–8, as well as the condition of the metals forming the composite. The illustration showing the carbon steel etched away from the stainless shows the most desirable physical contour of the bond. It will be noted from the actual specimen furnished that the bond does not occur in a smooth plane. An apt analogy is the case of two optical flats wrung together. They cannot be separated by tension normal to the bonded surfaces, but may be slipped apart. The non-planer bond in this composite metal is entirely free from this defect of bonding. The illustration showing the presumably martensitic structure in a very thin layer at the bond is characteristic of the process. That this layer in the bond does not affect the physical behavior is shown by the bent and severely deformed material. Many tests have been carried out in an attempt to break the composite metals apart in the bond. None has been successful.

The most severe test in the stainless carbon steel composite is the blister test where local heat is applied to the stainless side with an oxyacetylene blowpipe. The slightest defect in bond will result in a blister where the metal is heated. No such defects have been found.

The reason for this perfect score is perfectly simple. Had something gone wrong in the alloying operation, it would have been immediately discovered and the defect repaired by metal arc welding, using a stainless rod before the metal was rolled. There are no defects in the rolled metal for the reason that it would not have been rolled had there been any defects present. Further, in the case of 18–8, the martensitic structure in the bond is stronger than either the normal stainless or the carbon steel. It would not be expected that the stronger metal would break before the weaker.

Cost of Composite Metals Made by Carbon Arc Welding.—The factors which comprise the total cost of making composite metal by this method are ones with which steel mills are accustomed to deal so that cost of the product may be easily calculated. Thus, the alloy cost for the 18% chromium, 8% nickel metal is roughly 8¢ per pound. One 2500 ampere carbon arc will make about $2^1/_2$ pounds of the alloy on the surface of a preheated slab per minute. The power taken from the line is about 1.2 kwh. per pound of alloy made. Carbon electrodes, slag, etc. are almost a negligible factor in the cost. Cost of preheating slabs may vary from $2.00 to $5.00 per ton.

The out-of-pocket cost of material, heat, power and labor, obtain a 20% cladding of 18–8 on low carbon steel and hot rolling is of the order of $104.00 per ton of composite. The cost of making the alloy on the surface of the slab is approximately 15¢ per pound for 18% chromium and 8% nickel. Of the total of 15¢ per pound for this alloy, approximately 8¢ is for ferrochrome and nickel shot; the remainder being the cost of operating the process. The 18–8 metal being the most expensive ordinarily used represents the highest costs.

For costs of processing the composite beyond hot rolling a great deal depends on what is required. Pickling, grit blasting, cold reduction, polishing or other operations may be carried out at usual costs for these operations.

Adaptability of the Process.—A particular feature of the process is that it may be used by a steel producing plant which is not equipped with an electric furnace and trained personnel to produce solid stainless steel.

Since both the thickness of the slab worked on and the thickness of the alloy applied may be varied, the process is adaptable to the production of composite metals having a very thin coating of alloy. Perfection of the modern cold reduction process has opened up possibilities of a composite made of low carbon steel with a very thin coating of perhaps 17% chromium on one or both sides. Tin plate with as much as 40 pounds of tin per ton is a high grade product but it seems quite likely that the same steel with 40 pounds per ton of 17% chromium on the surface would offer longer life and better corrosion resistance. The same conditions apply to a comparison with galvanized steel. With an out-of-pocket cost of applying 17% chromium of the order of 10¢ per pound and an extra cost for grit blasting or belt grinding before pickling where the cladding is applied to only one side, the cost of the composite is still comparable to the cost of tin plate.

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ASSEMBLY PLANT FOR THE MASS

Production of Welded Barges and Other Structures

By GEORGE F. WOLFE*

A DECADE ago electric arc welding was generally conceded to be a rather fair means of doing emergency repair work. Then gradually, through indefatigable efforts on the part of arc welding equipment manufacturers and their sales forces, electric arc welding began to find a place in the fabricating and ship-building industries. To reach this point it was necessary not only to expound the merits of the new process but to displace to a large extent the use of riveting, a process so old that its very origin has been clouded by the passing centuries.

During the period of development the manufacturers of welding equipment have shown a united front in a common cause with the result that their progress has been astonishingly rapid in the perfecting of welding machines and electrodes The training of operators has been correspondingly active under the critical eye of the equipment manufacturers and their field representatives. But during all this time the users of the equipment have been left largely to their own individual resources to find economical means of production which will justify their usage of the newer and admittedly better processes.

Ten years ago the favorite outdoor sport of many engineering societies was an organized group visit to enable the members to see some actual welding operation in the plant of their most progressive local manufacturer. Today that engineer or manufacturer is indeed rare whose daily duties do not bring him into contact with his own welding problem or operation.

In some plants the change over to welding has been a gradual replacement of previous processes with but little alteration in the general methods of manufacturing. On the other hand, many industries and particularly such plants as structural fabricators and ship-builders do not lend themselves to this transition without the sacrifice of economical operation.

* Chairman of Welding Committee, Engineering Works Division, Dravo Corporation, Pittsburgh, Pa.

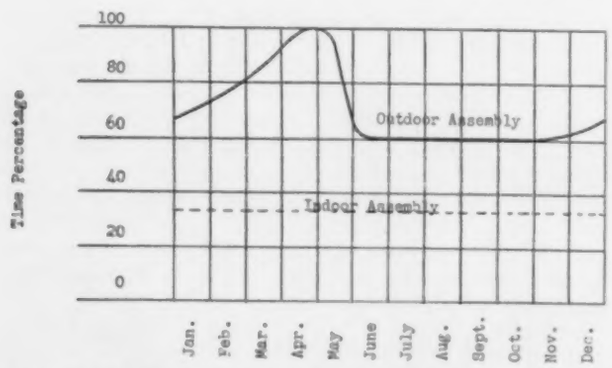


Fig. 1—Curve Showing Comparative Time Due to Seasonal Influence on the Erection of a Standard Coal Barge 175 Ft. Long by 26 Ft. Wide by 11 Ft. 0 Inches Deep

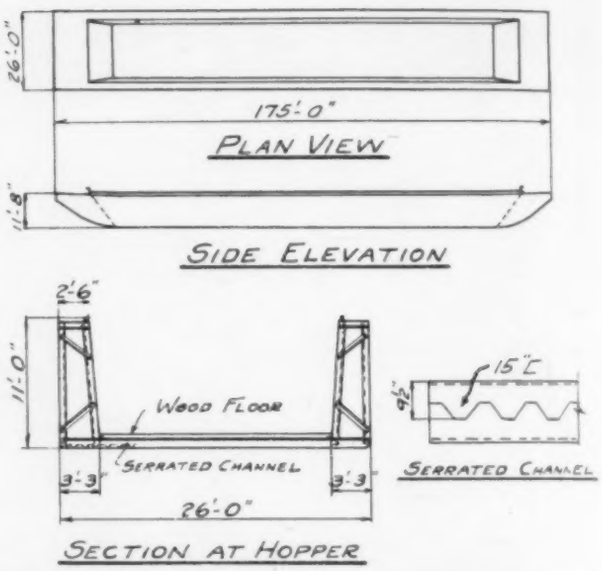


Fig. 2—This All-Welded Coal Barge, Dimensions 175 x 26 x 11 Ft., Is So Well Adapted to Positioned Preassembly Units That Only 16 Large Sections Are Required to Form the Complete Barge

The average first class structural or ship-building plant is equipped with hundreds of thousands of dollars worth of tools which can be used only for riveted work. Fortunately such tools as shears, planers, bend brakes, bending rolls and press equipment are all adapted for fabrication in connection with welding but there is an even greater list which is not. Most of the punches, spacing tables, drills and riveting equipment with all its numerous accessories must sooner or later be discarded. Methods of handling based on many years of riveting experience must be abandoned. New equipment must be developed and new methods of fabrication and handling must keep pace with the welding operation itself to enable the manufacturer to produce the better product at an economical cost.

The not so far distant scrapping of a large part of the riveting equipment will cause many a headache to the cost accountant who must be concerned with the depreciation and writing off of such once tangible assets which are rapidly becoming liabilities. The idea of the necessity of the scrapping of riveting equipment is not original with the writer. While visiting the plant of the Kampnagel Crane Company in Hamburg, Germany in 1932 it was evident that something was missing in their shops. A closer scrutiny revealed that this large structural and crane shop was devoid of all such tools as

Fig. 3—Aft End of Towboat Hull Erected Bottom Up for Positioning of the Welding on the Under Water Plating

Fig. 4—Forward and Mid Body Towboat Hull Sections After Transfer to Launching Ways

punches and riveting machines. The engineer who was acting as escort advised that five years previously their organization had decided that welding was here to stay and in order to effect no impediment to the development of weld ng they had discarded all of their riveting equipment (see Table 1).

The larger fabricators and ship-builders, with their present heavy burden of equipment mostly unsuited to welding, must compete for business with the small and, in many cases, new welding shops whose sole plant often consists of a light shed housing a small crane and one or more welding machines. This condition would indicate high profits for the small shop due to low overhead charges, but shops of this nature cannot meet mass production requirements, nor can they work economically until they make proper provision for the positioning of the work and the handling of large assemblies into the finished structure.

Table 1—Tabulation of Riveted and Welded Hulls Launched Annually During the Last Ten Years

Year	Riveted Hulls	Welded Hulls	Total Hulls
1928	126	0	126
1929	163	0	163
1930	124	0	124
1931	70	2	72
1932	13	0	13
1933	16	0	16
1934	34	6	40
1935	27	8	35
1936	9	95	104
1937	3	92	95
1938	3	72	75

The influence of weather conditions is shown in Fig. 1 where the comparative time is plotted for the completion of the same barge at different seasons of the year under average normal outdoor conditions and also in the barge Assembly Plant described herein. In the curves shown in Fig. 1 the performance in the month of April, which is poorest due to prevailing wet weather, is taken as 100 per cent and all other periods are proportioned thereto.

One of the chief benefits of the indoor assembly line method of production in the case of welded equipment is the ability to accurately schedule deliveries. The normal time cycle for the erection of the standard 175 ft. coal barge described above is ten days, and this time can be lessened by the addition of extra shifts if desired. The operation is entirely independent of all weather and seasonable variations shown in Fig. 1, which not only guarantees schedule requirements but also increases the efficiency of all of the various labor operations.

Shortly after the Assembly Plant was placed in operation in the Spring of 1937, a rush order of 25 coal barges, 140 x 26 x 10 ft., was divided between the indoor assembly line and the standard outdoor erection location. Working on the same identical barge in both locations simultaneously showed just double the elapsed time per barge for the outdoor job as contrasted to the indoor operation (Fig. 2).

In the building of all-welded hulls for towboats the barge Assembly Plant equipment has been used advantageously even when only one or two hull units are involved. A typical case was in the building of the hulls for two 350 horsepower, single screw, Diesel towboats where there was a decided advantage in building these full-formed hulls in an upside-down position to permit the use of down-hand welding on the underwater portion of the hulls. The hulls were assembled in three 30-ft. sections in the barge Assembly Plant, as portrayed in Fig. 4 which shows the aft end section as it neared completion. After completion of all welding the three heavy sections were transferred on the hydraulic transfer carriages to the launching ways, as shown in Fig. 3, where they were joined together into a complete structure. Consequently, the finished boat, which is shown in Fig. 5, consists of an all-welded hull and superstructure with all welds, except the two referred to above, performed under the most ideal conditions which will add years to the life of the boat and which will keep maintenance costs down to the minimum.

While the Assembly Plant was being designed it was generally recognized that the transfer carriages would be one of the most important parts of the entire system and subsequent events have confirmed this theory. After the Assembly Plant had been in operation less than one year an order for two 1200 cubic yard capacity all-welded bottom dump scows was offered Dravo Corporation which required delivery in half the time previously used on riveted scows of lesser size. The only possible way to guarantee this unusual delivery time was to route the job through the Assembly Plant on a twenty-four hour day, seven day week basis.

With this ability to guarantee delivery the order was secured and immediately a new problem arose. The transfer system had been designed to handle vessels up to a maximum weight of 300 tons while the scows had a total weight of about 750 tons each, with a minimum weight of more than 600 tons to be erected indoors. The problem was quickly solved by adding several more

Fig. 5—350 Horsepower Single Screw Towboat of Fully Positioned All-Welded Construction

transfer carriages to the system and in order to provide for future loadings of this nature the added carriages were built with a capacity of 120 tons each instead of 60 tons as in the original installation.

The scows, which were 206 x 40 x 14 ft., are shown in the outline drawing in Fig. 6. The main body of the scow consists of two side wings which are tied together at 18 foot intervals by the transverse bulkheads which form the vertical sides of the pockets. These side wings were particularly well adapted for the fabricating of large units and were built up in the structural shop into box sections eighteen feet in length weighing about 18 tons each. These box sections were assembled in jigs on the long side and were then rotated into various positions, in order to secure proper positioning. The erection of the scows in the Assembly Plant, as shown in Fig. 7, kept pace with the fabrication and the first scow was entirely assembled and ready for the addition of the doors and operating mechanism, as shown in Fig. 8, within eight weeks after the signing of the contract. This performance was possible only due to the fact that the work was carried on indoors as these large scows were built during the spring season when outdoor conditions were most unfavorable for welding production.

The Assembly Plant described herein was designed primarily for the mass production of floating equipment but due to the variable demand for barges and other floating craft it has been found advisable to use this plant for the handling of other units of fabrication.

Early in August 1937 an invitation was received to bid on Spillway Gates for the Pickwick and Guntersville Dams which are being constructed under the direction of the Tennessee Valley Authority. The Pickwick Dam requires twenty-three (23) gates and the Guntersville Dam nineteen (19), making a total of forty-two (42) gates in all with each gate having an upper and lower leaf, the lower leaf weighing approximately 65 tons when fully assembled and the upper leaf approximately 40 tons. In bidding on this work, on which Dravo Corporation was fortunate enough to secure the contract, it was decided that the most practical method for the handling of these heavy pieces would be to utilize the straight line method of production in the barge Assembly

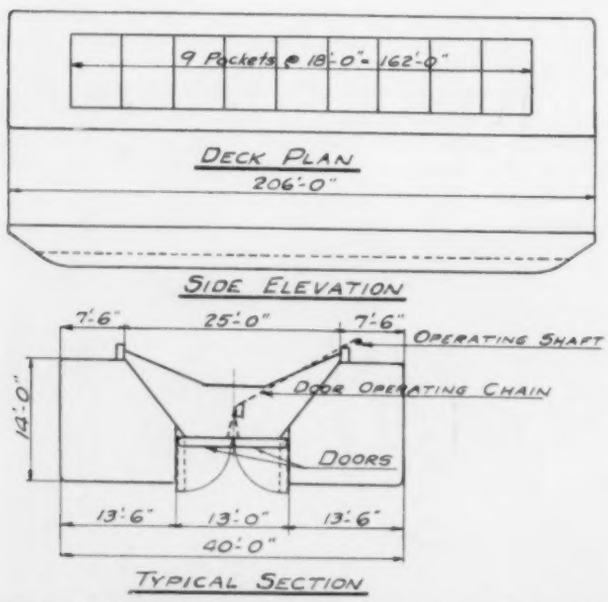
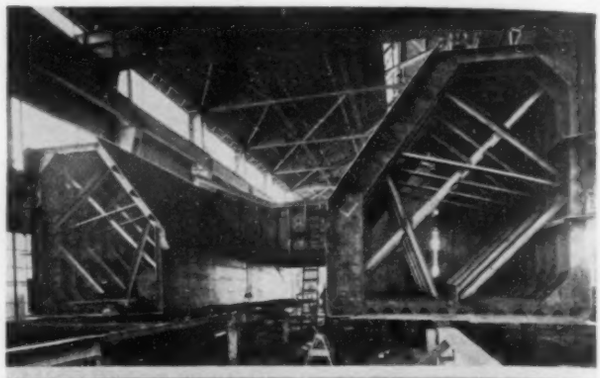


Fig. 6—These All-Welded Bottom Dump Scows with Overall Dimensions of 206 x 40 x 14 Ft. Have Side Wings 14 Ft. Deep by 13 Ft. 6 Inches Wide Which Were Preassembled Into Box Sections 18 Ft. Long Weighing 18 Tons Each Before Transfer to the Assembly Plant for Erection Into the Complete Scows

Fig. 7—Erection Started in Assembly Plant 3 Weeks After Award of Contract



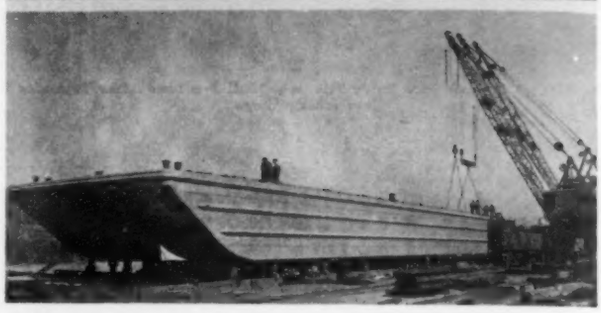


Fig. 8—Scow Ready for Machinery and Door Installation Eight Weeks After Signing of Contract. Vessel Completed Two Weeks Later

Plant where the hydraulic transfer carriages would be available for the moving about of these heavy loads

The gates are 20 ft. in height and 41 ft. in length with a flat skin plate carried on a system of horizontal supporting girders. The attachment of the $^1/_2$-inch skin plate to the girders is entirely by welding, there being no holes in the skin plate, while the balance of the construction, including the stiffening girders and various diaphragms, is entirely of riveted construction. The skin plate is in three horizontal strakes with the splicing of these strakes over the flanges of the girders. The splice is made by separating the plates $1^1/_4$ inches and running a $^1/_2$-inch continuous weld the full length of the gate on each side of each strake of plating. Since this type of construction called for a considerable amount of welding on each side of the skin plate it was necessary to turn the fully assembled structural portions of the gates, weighing about 50 tons in the case of the lower leaf, completely over during fabrication in order to secure the benefits of positioning for down-hand welding. The straight line method of assembly fitted in very nicely with this type of fabrication and the barge Assembly Plant equipment was quite sufficient for the handling of the loads involved.

The assembly of the various parts into complete units was started at the upper end of the shop. The assembled units were carried progressively forward until all riveting was completed as well as all welding on the back or girder side of the skin plate while this side was upward. "A" frames were then provided and with temporary trunnions bolted to the ends of the gate leaves as a means of partial support, the 50-ton units were readily turned over, as shown in Fig. 9, with the much lighter capacity crane overhead. After the welding of the skin plate, the gate was turned back over to its former position and then was carried forward to the boring mills, where holes were bored at each end of the gate leaves for the overhung axles.

Following the boring operation the gate leaves were

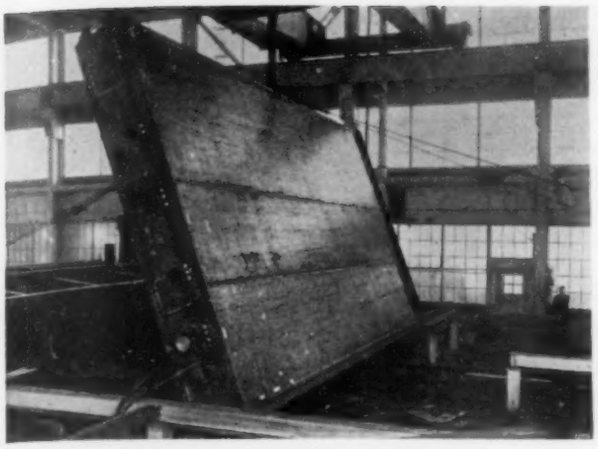


Fig. 9—Turning Lower Leaf After Welding Skin Plate in Down-Hand Position

lifted by the hydraulic transfer carriages and taken out of the building where change of direction of movement was accomplished. From this point the gate leaves were passed through a sand-blast station prior to painting. Since the outdoor painting operation was delayed at times due to weather conditions the gate leaves were stored on temporary blocking.

One of the inherent qualities of the Assembly Plant handling methods of erection of vessels is from the safety view-point. The permanent steel blocking throughout the plant is a long step forward from the normal outdoor operation which required removable timber blocking which is frequently supported on uncertain foundations. During the moving of the heavy loads the risk to the workmen is reduced to a minimum as the vessels are never lifted more than a few inches above the fixed steel blocking and the transfer carriages are provided with safety stops to catch the load if any leakage should develop in the hydraulic jacking system.

In the designing of such plants as described herein one should give careful consideration to the possibilities of future requirements. Due to the large capital expenditures involved and the difficulty of securing appropriations for plant expansion, the tendency will be to provide for present requirements only. The designers must look ahead and so design their equipment as to permit future increases in capacity without making radical changes in the original installations, always bearing in mind that today's maximum requirements are tomorrow's minimums.

In order to make Electric Arc Welding truly competitive with other processes new fabrication methods must be developed. The Assembly Plant described herein is only a partial answer to the problems of one manufacturer. Each branch of industry will present its own particular problem and each in turn must be solved in order that the purchaser of the finished product may receive the maximum of value for his expenditure.

Electric Arc Welding has had its greatest development during the depression years and the demand for mass production and scheduled deliveries, which are synonymous with the return of normal times, has not yet confronted the welding industry. With the increasing demand for all-welded construction many of the points touched upon will suggest their own solution. Obsolete equipment will be replaced with proper tools for welding only; critical inspection will require positioning to the greatest possible degree; maximum productive efficiency will dictate housed operations to the fullest extent, and the net result of all these and many other improvements will be economical and profitable production which is the ultimate aim of every manufacturer.

WELDING STEEL PIPE IN SUB-ZERO Temperatures

By G. H. GARRETT*

A FEW years ago the fusion welding of steel pipe lines and similar steel structures in sub-zero temperatures was not only unheard of but impossible. Sometimes seams of welded steel structures broke when the atmospheric temperatures dropped sharply. However, with the advent of heavy coated rods, and the improvement in welding technique it is now possible to weld low carbon steels when the atmospheric temperature is many degrees below zero. In the winter of 1936–37 our company had occasion to prove this in the execution of a contract with the Denver Board of Water Commissioners for the construction of two steel pipe lines in the heart of the Rocky Mountains near West Portal, Colorado.

The two pipe lines are known as Siphon No. One and Siphon No. Two. They are for the purpose of diverting water from the western slope of the Continental Divide through the six mile Moffat Water Tunnel to the eastern slope for use by the City of Denver. The pipes are full of water in the spring and summer, and are empty during the fall and winter. The west portal of the Moffat Water Tunnel is at elevation 9091 feet above sea level. It is not unusual during the winter where these pipe lines are installed for the temperature to drop as low as 50° below zero. While the construction of the pipe lines was in progress the temperature for a period of thirty days was 35 to 52° below zero at 8:00 o'clock every morning. During the day the temperature rose to 10° or 15° below zero. Welding continued through this very cold period. Progress, on account of the high altitude, in addition to the extreme cold, was naturally very slow; however, the quality of the welding was very satisfactory.

Siphon No. One is 72 inches in diameter and delivers water into the west portal of the tunnel at a pressure of 119 lb. per square inch. Its total length is 1850 feet; of which 1058 feet are of $^1/_4$-inch and $^5/_{16}$-inch wall, and are supported with stiffener rings and rollers on low concrete piers at 50 foot centers; 579 feet are buried and of $^7/_{16}$-inch wall; and 213 feet across the Fraser River and the highway at West Portal are of $^7/_{16}$-inch and $^9/_{16}$-inch wall, and are supported on stiffener rings, and high hinged steel bents at 50 foot and 67 foot centers. Siphon No. Two is 78-inches in diameter, 955 feet long, and has a wall thickness of $^1/_4$ inch to $^3/_8$ inch. It is supported with stiffener rings and rollers on low concrete piers at 50 foot centers.

All steel used in the construction of the pipe lines was flange quality A. S. T. M.—A70–33. The welding, both at the factory and in the field, was done in accordance

* Vice-President and Chief Engineer, The Thompson Manufacturing Co., Denver, Colo.

with paragraph U-69 of the A. S. M. E. Boiler Code, Unfired Pressure Vessel Section. Field operators were qualified for all positions. Factory longitudinal seams were a tight butt joint, welded by one pass inside and one pass outside with an automatic head. Factory girth seams were backed up manually inside, using one pass of shielded arc rod, and on the outside using an automatic head. The field seams for plate thicknesses of $^3/_8$-inch and less were bell and spigot inserted $1^1/_2$ inch and welded with a 45° fillet weld inside and outside. Field seams for plates $^7/_{16}$-inch thick were single V butt welded. The V being on the outside of the pipe for the bottom half of the circumference, and on the inside for the upper half. The V was 45° $^3/_{16}$-inch deep. For this type of seam three passes were made on the outside and three passes on the inside using a heavily coated $^3/_{16}$-inch rod. The machine setting was 34 to 36 volts and 175 to 200 amperes. The first and second passes on each side were stepped-back. The last pass was continuous. The finish pass was held as nearly flush as practical. No attempt was made either at the factory or in the field to stress relieve any of the welds. The $^7/_{16}$-inch and $^9/_{16}$-inch wall pipe on the high steel bents was fabricated so that each span consisted of two pipe lengths. One length had the stiffener ring in its center, the other was an intermediate piece. The erection procedure was to tack weld intermediate lengths to the end of the previously erected piece and let it hang cantilever until the adjacent length, with its steel support was tack welded to it. This procedure did away with any scaffolding or temporary intermediate supports. Four tack welds 10 to 12 inches long were used. The pipe with the $^7/_{16}$-inch and $^9/_{16}$-inch wall was erected and welded during the thirty day extreme cold period mentioned above. The pipe lines have now had two severe winter tests to prove that welding in sub-zero weather is satisfactory when proper procedure is followed.

Fig. 1—Operator Welding Field Seam Using a Simple Scaffold. The Simple Scaffold Allows Him to Reach the Entire Circumference of the Seam. At the Time the Picture Was Taken the Temperature Was 35° Below Zero

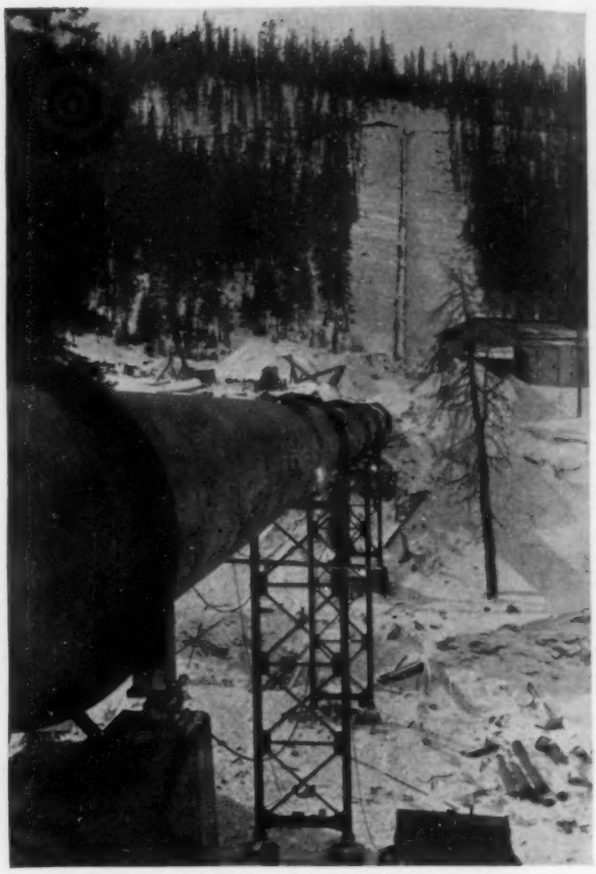


Fig. 2—Siphon No. 1, 72 Inches in Diameter

WELDING HANDBOOK

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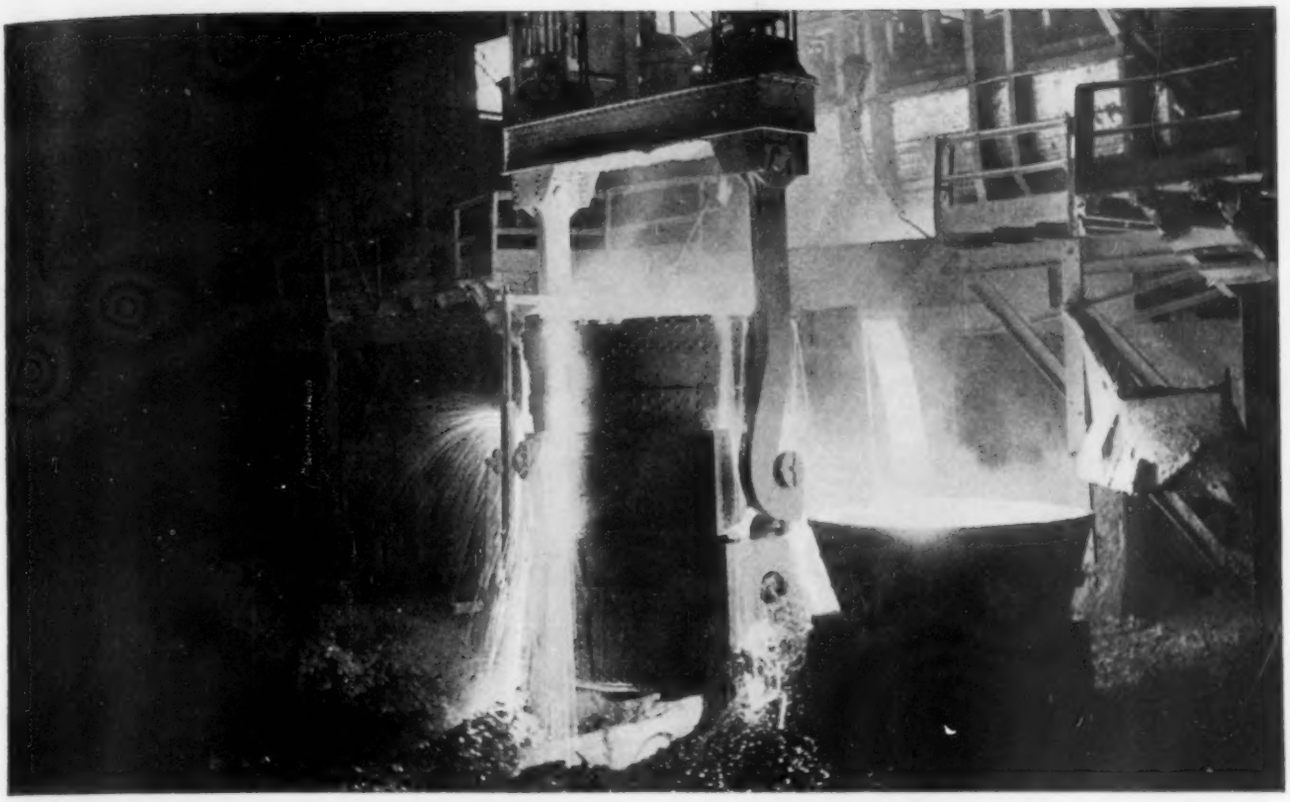


The Oxyacetylene Process Is Indispensable to the Modern Steel Mill

THE OXYACETYLENE PROCESS Simplifies Steel Production

By W. S. WALKER*

THE EXPERIENCE OF THE LAKESIDE PLANT, OTIS STEEL CO., CLEVELAND

FEW industries find the oxyacetylene process as vitally essential as does the modern steel mill. The process is required not only in the processing of the steel itself, but also for countless operations in the fabrication and maintenance of steel mill equipment. To attempt to describe the many applications is far beyond the scope of this review. However, the jobs illustrated on the following pages are typical of the work being performed by one well-known mill engaged in the production of plates, sheets and hot- and cold-rolled strip.

The oxyacetylene operations in this mill may be conveniently classified into five groups: (1) flame-conditioning, (2) lancing operations, (3) open-hearth maintenance, (4) machine-cutting and (5) welding shop operations. Before discussing each of these groups, a brief consideration of the oxygen piping system will be of assistance in more readily visualizing how the oxyacetylene process fits into the various production and maintenance operations.

OXYGEN DISTRIBUTION

The pipe-line first runs the length of the open-hearth building where stations are located at each open hearth as well as along the pouring platform. At the end of the building are several additional stations for open-hearth maintenance operations.

From the open hearth, the oxygen piping crosses the slab yard. Here, there are 10 or 12 stations for deseaming operations, and one for a cutting machine installation. The piping next runs the length of the blooming mill and strip mill, then crosses the scrap yard. Finally it branches, one line going to the locomotive shop and the other to the coke works and blast furnace.

The welding shop has its own supply of oxygen and acetylene. In addition, there are over a hundred portable welding and cutting outfits at various points about the mill.

FLAME-CONDITIONING

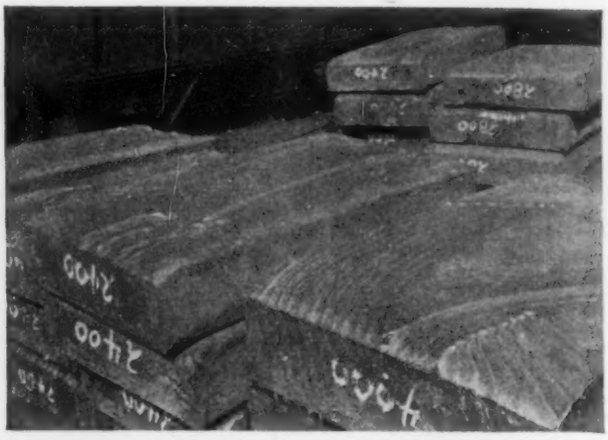
In this mill, slabs and other semi-finished shapes are conditioned by means of hand-deseaming blowpipes. Slabs from the bloomer are laid out, cooled, sorted and inspected in the slab yard, then moved by crane to the deseaming bed where the scale is removed and surface defects are indicated by chalk marks. These defects are then quickly and economically removed by deseaming.

The accompanying photographs illustrate the opera-

* The Linde Air Products Co.

This View of the Slab Yard Shows the Slabs Laid Out for Deseaming. The Operator Is in the Upper Right Corner

For Starting on the Edge of the Slab, the Blowpipe Is Held Horizontally. After 2 Sec. for Preheating, the Nozzle Is Raised to an Angle of 30° and the Oxygen Turned On



This Close-Up Shows Deseaming in Progress. The Nozzle Proceeds Across the Work at About 30 Ft. per Min., Producing a Shallow Path 1 1/2 Inches Wide. The Depth of the Path Varies from 1/8 to 1/4 Inch, Depending on the Angle of Blowpipe Speed of Travel and Oxygen Pressure. On the Right Is a Group of Flame-Conditioned Slabs

tion quite clearly. In this particular instance, most of the cuts were started at the edge of the slabs, so the blowpipe was not equipped with a starting rod attachment. However, for the majority of work, and especially for spot deseaming, a starting rod attachment is used. This considerably shortens the time required for preheating when the cut is started on the flat surface of the slab.

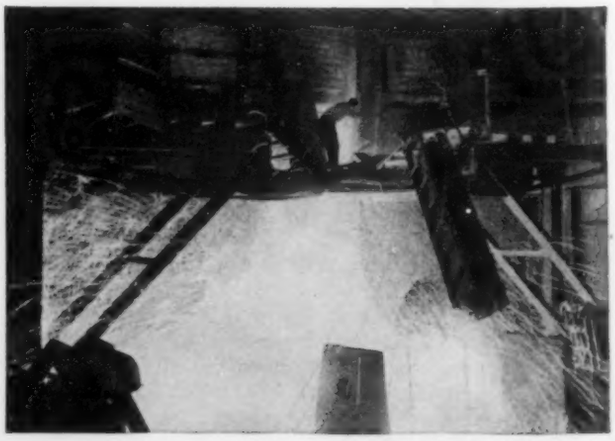
In other mills, billets and slabs are flame-conditioned not only by means of hand deseaming, but also by mechanical conditioning machines.

LANCING OPERATIONS

Without the oxygen lance, many steel mill operations would be greatly hampered. For years, the lance has been used as a routine method for opening tap holes in blast furnaces and open-hearth furnaces, for tapping slag from soaking pits, for cutting up spills and skulls, and for many other operations involving the piercing or severing of extremely heavy masses of iron and steel.

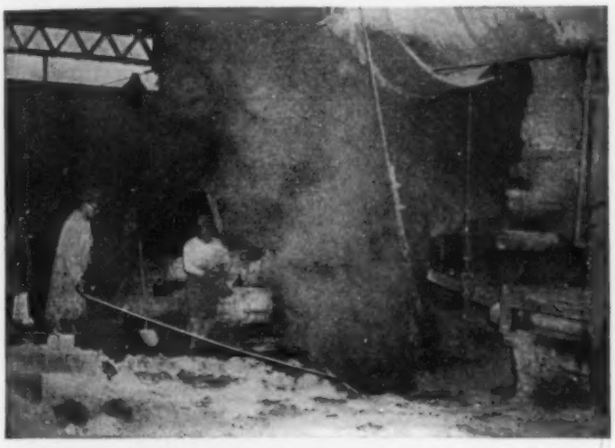
The illustrations indicate three typical lancing operations. The lance usually consists of Standard 1/4-inch or 3/8-inch black iron pipe approximately 20 ft. long which is connected to a suitable supply of oxygen at a pressure of between 75 to 125 lb. per sq. in.

Various methods are used to start the lance. At the blast furnace it is usually lit from a pile of burning coke, while in severing skulls a cutting blowpipe is used to start the operation. At the open hearth, the heat of the molten metal in the furnace is sufficient to start the cutting reaction.



The Oxygen Lance Is Used for Cleaning the Open-Hearth Slag Hole, as Shown Here, as Well as for Furnace Tapping

(Left) About 1/2 Min. Is Required to Start the Skull-Cutting Operation with a Hand Blowpipe. The Skull Is Then Pierced with the Lance 6 Inch from the Top, After Which This Upper Section Is Cut Away. (Center) The Lance Is Moved Back and Forth as the Cutting Proceeds Downward. (Right) This 6-Ton Skull Was Severed in 3 Hr.



Blast Furnace Tapping. Only a Few Seconds Are Required for the Lance to Burn Through the Solidified Metal in the Iron Notch, Thus Releasing the Stream of Molten Pig Iron

This General View of the Open-Hearth Welding Department Shows Two Operators at Work on Door Frames

OPEN-HEARTH MAINTENANCE

In a corner of the open-hearth building, a special welding department has been established to handle nothing but the maintenance of the open-hearth furnaces, particularly the repair of water-cooled doors and door frames.

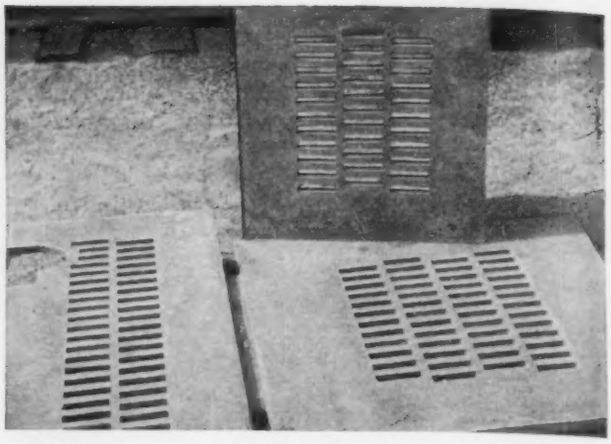
Because of the frequency with which repairs must be made, work is scheduled on a semi-production basis. The eight open hearths in this mill have 40 doors, and, on an average, 3 door frames are repaired daily. The shop personnel handling this work consists of one cutting operator, three welding operators and one boilermaker.

Where doors and frames have cracked, the cracks are cut out with the cutting blowpipe and then welded.

This Furnace Burner and Water-Cooled Furnace Tuyère Were Fabricated Entirely by Cutting and Welding

Oftentimes It Is Necessary to Replace Whole New Fronts of Door Frames. The Steel Plate Is First Cut to Shape, Then Heated and Bent Over a Forming Block. Finally, the Damaged Sections Are Cut Out and the New Front Welded in Place

Where Cracks in the Door Frames Are Only Slight, They Are First Cut Out with the Cutting Blowpipe and Then Beveled for Welding with High-Test Steel Welding Rod



These Sewer Covers Were Machine-Cut from 1½-Inch Plate. The Dimensions of the Grating Holes Are 1 Inch by 5 Inches

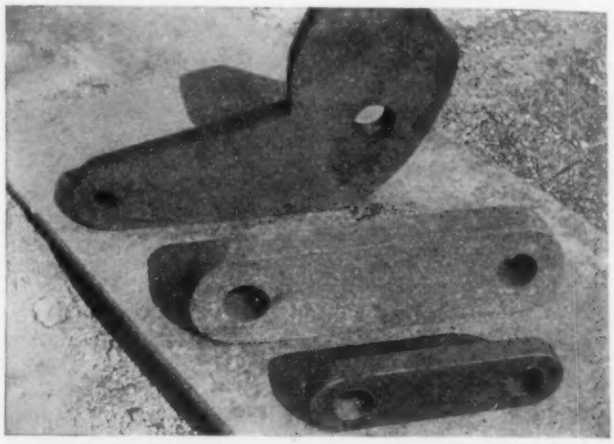
Usually the frames are badly worn and cracked, however, and it is necessary to replace them with whole sections. This department also takes care of the maintenance of open-hearth burners, tuyères, and flue dampers, as well as other miscellaneous welding and cutting operations around the furnaces.

MACHINE-CUTTING OPERATIONS

At one end of the slab yard, adjoining the blooming mill, is a small shed which houses a portable oxyacetylene cutting machine. This machine is used for fabricating the wide variety of replacement parts necessary for the maintenance of the steel mill equipment. By locating the cutting machine in the slab yard, instead of in the welding shop which is some distance away, it is conveniently near the large slabs and plates which are often necessary for shaping the parts required.

The jobs illustrated are typical of the work performed. Other parts regularly produced are gag blocks for hydraulic shears (8 inches thick), lips for blooming mill spindles, all types and sizes of sheaves, and other parts required for the maintenance of the rolling mill equipment.

The plate mill of this steel company is located in another plant which is equipped with a number of stationary and portable cutting machines for shaping plate to customer's requirements.



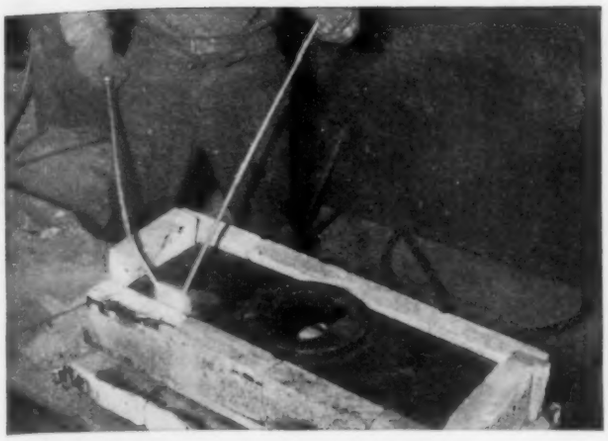
The Conveyor Links in the Foreground and Ladle Dog in the Background Were Fabricated by Machine Cutting

WELDING SHOP OPERATIONS

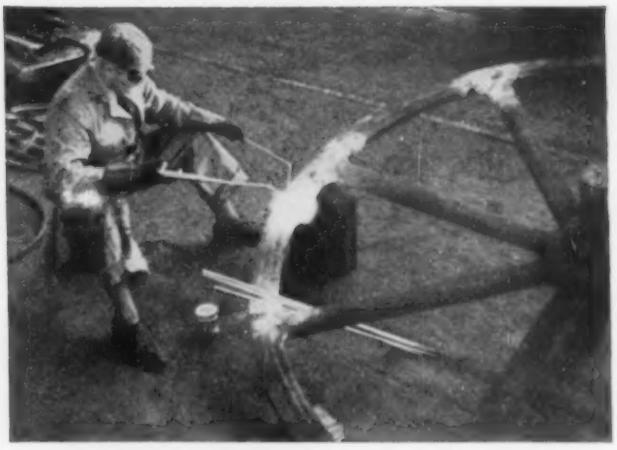
In the welding shop, the oxyacetylene process is used for a wide variety of maintenance and repair operations including hand-cutting, steel-welding, bronze-welding, hard-facing and flame-hardening.

Flame-hardening applications in this mill include all sorts of gears, such as those for vertical rolls and line

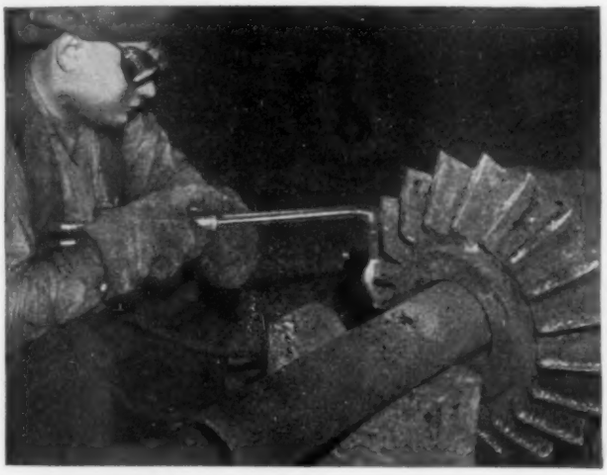
These Carrying Rolls Between the Bloomer and Hydraulic Shears Are Fabricated of Flame-Cut Rings Which Are Shrunk-Fit on a Shaft, Then Welded in Place. The Center View Shows the Setup for Cutting the Rings. Disks 14 Inches in Diameter Are First Cut from 2½-Inch Plate, Then a 9-Inch Diameter Hole Is Cut Out of the Center of Each of the Disks



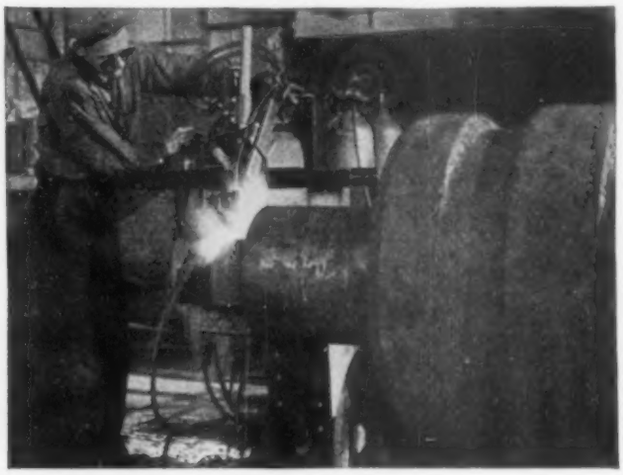
When This Bronze Slipper for a Universal Spindle Wears 3/8 Inch, It Is Rebuilt with 125 Lb. of Bronze-Welding Rod



This Blast Furnace Skip Hoist Sheave Was Repaired by Bronze-Welding at One-Tenth the Cost of a New Wheel



The Worn Teeth of This Bevel Gear for Driving the Bloomer Carrying Table Rolls Are Being Trimmed to Shape with the Blowpipe. They Are Then Rebuilt with Wear-Resistant Rod



Roll Wobbler Pads Are Readily Flame-Hardened by Means of This Ideal Setup. A Hard, Wear-Resistant Surface Is Produced, Yet the Core Material Is Both Tough and Ductile

shafts, brake shoes and brake bands, wobbler pads, guide bars, rollers and pins, leveler rolls, and pinions and sprockets. Hard-facing is used for lengthening the life of rolling mill guides, shear blades, filler sleeves, coke pusher shoes, gag press hammers, ingot crane tong points, and many other parts subjected to heat and abrasion. Welding and cutting are used not only for maintenance operations, but also for the fabrication of steel mill equipment such as the previously described carrying rolls between the bloomer and hydraulic shears.

The four jobs illustrated are typical of the economies possible through the effective use of the oxyacetylene process.

Lighter and Stronger Concrete Molds

BY ALAN KELLOCK*

WELDING AND CUTTING USED IN MAKING SHEET METAL SECTIONS

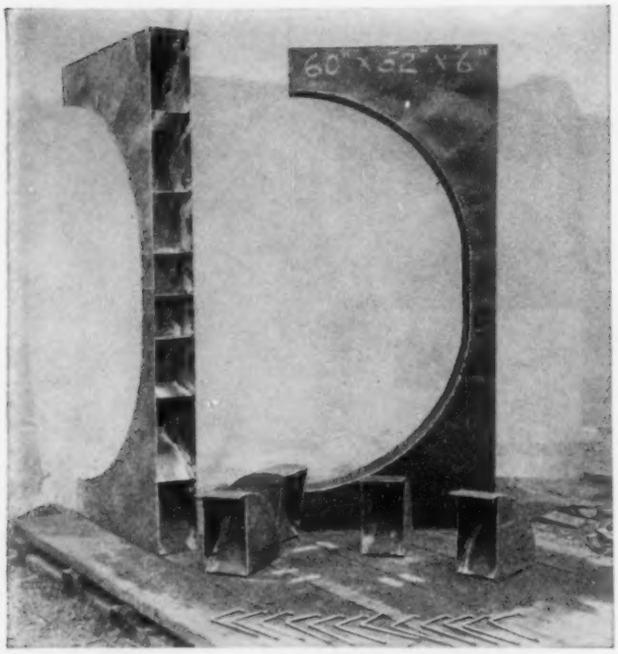
CONCRETE ring molds, fabricated from sheet metal by oxyacetylene welding and cutting, have proved so superior in convenience and service to the bulky wooden molds previously used, that a municipal water department has recently adopted the new welded design as standard for all molds of this type. The molds were designed by the department's chief engineer, for casting annular concrete sections which, piled one upon another, are used in building up manholes from the water gates or valves to the manhole openings at street level.

* The Linde Air Products Co.

MADE IN SECTIONS

The various parts for each mold were cut to shape from $^1/_{16}$-inch sheet steel by means of a hand-cutting blowpipe guided along an outline which was traced on the metal with soapstone. The inside edges of the mold were then steel welded. To add strength and rigidity to the structure, reinforcing fins were placed between the top and bottom sheets of the mold, and tack-welded with bronze-welding rod.

The molds were made in sections which can be mounted



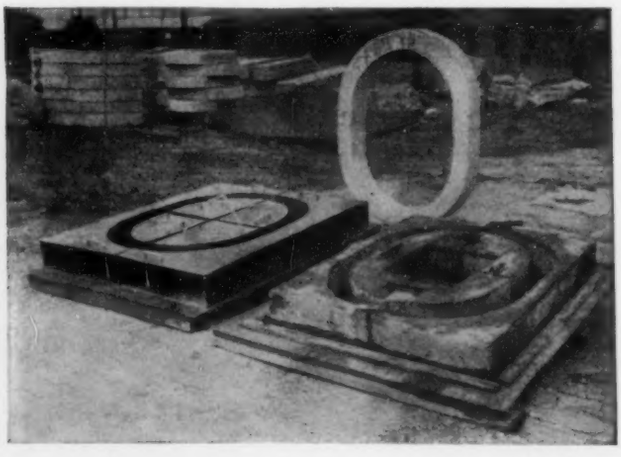
When Assembled, the Sections Are Held in Place by Pins (Foreground) Whose Ends Fit in Steel Sockets Set in the Wooden Base

on a wooden base. When new castings are needed, the mold sections are assembled and held in correct position by pins which pass through holes in the mold parts and terminate in steel sockets placed in the wooden platform. Overlapping sections of metal assure snug fits and prevent the wet concrete from lodging in the cracks between the various sections of the mold. When the concrete is hardened, the mold is broken by simply pulling out the pins and removing the sections. The concrete ring is then ready to be used.

OLD TYPES DAMAGED BY WATER

Before the welded forms were devised, the molds were made of wood, the faces of the mold being lined with zinc sheet metal. They proved quite unsatisfactory because in winter, water would get into the wood and freeze, causing the wood to disintegrate and to become distorted. Also, the wooden forms were bulky and difficult to handle, especially when they became water-soaked. The new molds are strong, light, easy to handle and are unaffected by water.

Approximately 15 lb. of welding rod and about 1 cylinder of oxygen are required to fabricate and weld one large-sized mold for casting a ring 6 inches thick, 42 inches long, and 30 inches wide, and one smaller mold for a ring 6 by 35 by 25 inches. Total fabricating time for the two molds is about 80 hr., which is about one-half the time required to fabricate the old style wooden molds. The steel molds are expected to last much longer than the old ones, and in the future all these molds will be fabricated by oxyacetylene welding.



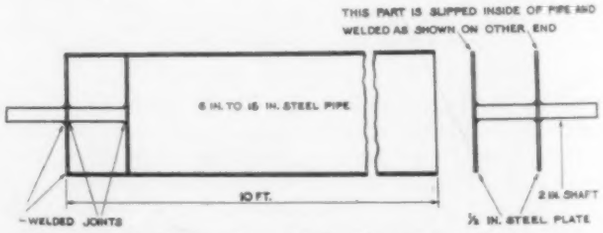
Sheet Steel Concrete Molds (Left) Are Lighter, Easier to Handle and Assemble, and Last Longer Than the Bulky Wooden Molds Previously Used

Felt Rolls for Paper Making

By GEORGE SYKES*

ROLLS FABRICATED BY WELDING SAVED 83 PER CENT

IT HAS been found by a paper manufacturing company on the West Coast that the fabrication of felt rolls from steel pipe by cutting and welding effects a saving of 83 per cent as compared to the older method of making the rolls in one piece. The felt roll is part of the paper making machine and there are a considerable number of these rolls on each machine.


THIS PART IS SLIPPED INSIDE OF PIPE AND WELDED AS SHOWN ON OTHER END
6 IN. TO 16 IN. STEEL PIPE
10 FT.
2 IN. SHAFT
WELDED JOINTS
½ IN. STEEL PLATE

Rough Sketch Showing Assembly Details of Paper Manufacturing Felt Roll

It will be observed from the accompanying sketch that the main body of the roll, as now fabricated, consists essentially of a length of steel pipe 6 to 16 inches in diameter, depending upon the size needed. Each roll is approximately 10 feet long. The roll is supported and held in alignment by 2 blanking plates at each end into which are fitted lengths of 2-inch shafting. The two blanking plates at each end of the roll give stability and strength to the assembly. Both plates are cut to fit the inside diameter of the pipe roll and are usually made of $^1/_2$-inch mild carbon steel plate. The sketch illustrates clearly how the roll is assembled and welded.

The paper company has found that by fabricating the rolls in this fashion, the cost is but one-sixth of what they had previously paid to have them made by other methods.

* The Linde Air Products Co.

WELDED STEEL SUPPORTING Structures for Continuous Process Rayon Producing Machines*

By R. F. BERGMANN† and A. F. MacDONALD‡

ONE of the leading rayon producers in the United States now has under construction an 11,000,000 pound annual capacity plant, which will embody the world's first commercial installation of equipment for the continuous spinning, processing, drying and twisting of high quality viscose rayon yarn for woven fabrics.

The process itself, made possible by an ingenious, highly developed reel composed of chemically resistant molded plastic members, is the result of years of experimental and developmental effort. Continuous spinning and processing of viscose rayon yarn is now considered an accomplished commercial achievement, based on the successful operation of a complete, full-size test or "pilot" machine at one of the company's existing plants.

A wholly owned machinery subsidiary has been organized to refine and commercialize the design, exploit and manufacture or contract for quantity production of machine parts, assemble and erect complete installations both for the parent company as well as all rayon yarn producers, domestic and foreign.

Of the 312,236,000 pounds of rayon yarn produced in the United States in 1937, approximately 75% was accounted for by the viscose process. It remains the lowest cost process yielding a satisfactory yarn, mainly due to the lower cost of the basic raw material and the chemicals used in treating the yarn.

Efforts further to lower the cost of producing viscose yarn by reducing the number of processing steps had previously resulted only in an inferior product, by no means suited to broader distribution. Consequently, further cost reduction together with improvements in quality of product are believed to lie in obtaining the required series of treatments as economically as possible, with a minimum of handling and interruption, and with the greatest uniformity of treatment obtainable.

Figure 1 presents comparative flow or process diagrams for typical pot spun, spool spun and the new continuously spun and processed viscose rayon yarn.

The adaptability of arc-welded steel frame members to the structure required for the continuous machine, and the exceptionally large saving in cost and weight as compared with that of cast and machined members serving the same purpose, is proving a major factor in the economical first cost and commercial development of the process described briefly in the following.

On the conventional pot spinning (centrifugal) machine, viscose is carried down each side by a pipe through a valve to a small gear or piston pump at each spinning position, then through a unit filter and, finally, through a tube or "rounder end" to the spinning jet submerged in the acid bath. The jet has from 40 to 90 small holes through which the viscose is extruded. As the viscose coagulates on leaving the jet and entering the bath, each hole produces a separate and distinct filament of the yarn.

The coagulated yarn is constantly drawn away from the jet, up through the bath, by a glass "godet" roller independently driven from the geared head of the machine. The pump speed and consequent delivery of viscose and the rotation of the godet, are geared in proper relation to produce a finished yarn of the desired weight per unit of length.

From the godet roller the yarn is fed into the inside of a molded plastic spinning pot. The pot rotates at a speed of 8000 to 10,000 r.p.m. on a flexible spindle which also carries the rotor of an individual vertical electric motor at each spinning position. A frequency converter is employed to govern the speed of the motors.

The centrifugal force exerted by the yarn against the walls of the revolving pot, together with the traverse motion imparted by a pantograph frame, causes the yarn to build up in the form of an annular ring known

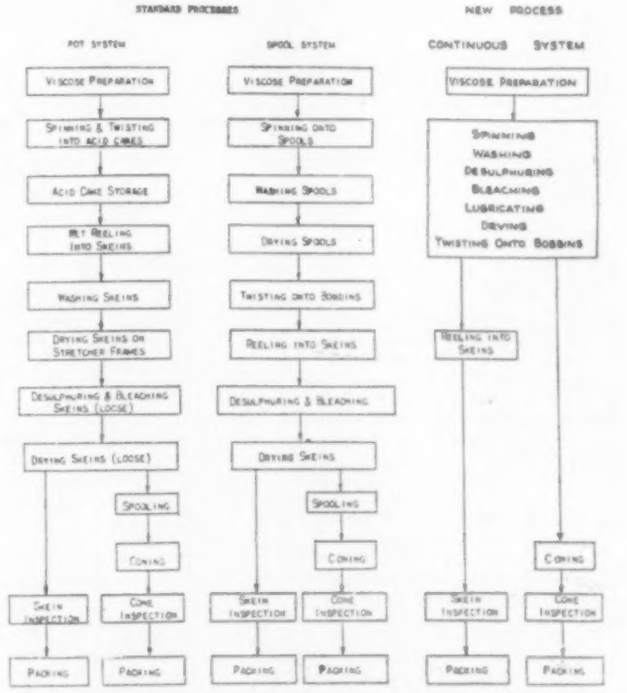


Fig. 1—Comparative Flow or Process Diagrams for Typical Pot Spun, Spool Spun and the New Continuously Spun and Processed Viscose Rayon Yarn

* The authors of this paper received the fourth award, $1,526.33 of the Industry Machinery Classification of the $200,000 Program sponsored by the James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, in which savings of $1,600,000,000 were shown available to industry by wider application of arc welding.

† Chief Engineer, Rayon Machinery Corporation, Cleveland, O.

‡ Designing Engineer, American Bridge Company, Pittsburgh, Pa.

in the industry as a cake. The rate of feed of yarn into the pot, in conjunction with the high rotating speed of the pot, causes a twist of $2^1/_2$ to 3 turns per inch to be put into the yarn.

The spool spinning machine is similar in general design to the pot spinner. The spool, located in about the same position as the godet, is usually made of perforated aluminum coated with an acid resisting paint. Leaving the jet, the coagulated yarn is carried up through the bath to a thread guide mounted on a traverse mechanism which lays the yarn evenly on the revolving spool. To compensate for the increasing package diameter as the yarn builds up on the spool, a differential speed control device is incorporated in the spool drive at the geared head of the machine, so as to produce finished yarn of predetermined, uniform weight per unit of length.

Referring again to Fig. 1, if the freshly spun yarn is allowed to dry when restricted in cakes or on spools, it will develop inequalities in its properties depending upon strains to which the yarn is subjected. Further, yarn in any such bundle or package is subject to varying intensity of treatment, both chemical and physical, depending upon which part of the yarn is more exposed.

Such irregularities are minimized by reeling the wet yarn into skeins, which are processed and dried in a loose and free condition. Successive operations listed in the first two columns of Fig. 1, are typical in the manufacture of pot or spool spun viscose yarn for woven fabrics, where quality and uniformity are essential. Each block on the chart represents an operation, and each arrow a handling required to prepare a cone of finished, bleached and twisted yarn ready for the market.

In the spool system, twisting does not take place coincidental with spinning as is true with the centrifugal process. Some form of equipment for twisting as a separate operation is necessary.

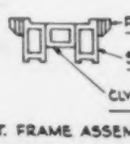
The new process combines into one continuous series of operations all steps from spinning to drying and twisting on bobbins, as shown in Fig. 1.

This is accomplished by building into one complete machine a simple modification of the spool spinner equipped with continuous reels; a "stepped" inclined processing panel also equipped with continuous reels on which the yarn is chemically treated, washed and dried as it travels from one reel to another down a vertical run; and finally, a cap twister.

The most logical arrangement of combining the several units was to superimpose them for reasons of compactness and economy of floor space, ease of threading when starting or resuming operations on any position and for the convenient application of the transmission equipment for driving the various operating mechanisms.

The common spin trough serves spinning jets pivoted from both sides. This design permits the narrowest and lightest frame construction believed practical. From this width the machine "builds out" due to the stepped

CAST IRON DESIGN

DESCRIPTION	REQ'D. FOR ONE ASSEMBLY			REQ'D. FOR ONE MACHINE	
	NUMBER OF PARTS	WEIGHT EACH	WEIGHT PER ASSY.	NR OF ASSYS.	WEIGHT
"A" FRAME	1	660	660		
SAMSONS	2	440	880		
CYLINDER FRAME	1	320	320		
INT. FRAME ASSEMBLY	TOTAL WT.		1860	5	9300#
"A" FRAME	1	660	660		
SAMSON	1	440	440		
CYLINDER FRAME	1	240	240		
DRIVE SAMSON	1	900	900		
DRIVE END FRAME ASSEMBLY	TOTAL WT.		2240	1	2240#
 PANEL BRKT'S.	2	130	260		
SAMSONS	2	400	800		
CLYINDER FRAME	1	240	240		
INT. FRAME ASSEMBLY - "F"	TOTAL WT.		1300	5	6500#
INT. SPIN FRAMES	1	260	260	5	1300#
DRIVE END SPIN FRAMES	1	600	600	1	600#
PROCESS PANELS	1 1	1400 2000	3400	10	34000#
TRAVERSE LIFTER BEAM	1	145	145	10	1450#
SPINDLE RAIL BRACKETS	1	25	25	12	300#
PROCESS DECK BRACKETS	1	115	115	12	1380#
SPIN HOOD BRACKETS	1	10	10	10	100#
SPIN APRON BRACKETS	1	30	30	12	360#
TOTAL WEIGHT CAST IRON PARTS PER MACHINE					57,530#

WELDED STEEL DESIGN

DESCRIPTION	REQ'D. FOR ONE MACHINE		
	NUMBER OF PARTS	WEIGHT EACH	TOTAL
INT. FRAMES	5	1000	5000#
DRIVE END FRAMES	1	1450	1450#
CYLINDER BEARING SUPPORTS	5	170	850#
ROCKER SHAFT BEAR. SUPPORTS	10	185	1850#
INT. SPIN FRAMES	5	180	900#
DRIVE END SPIN FRAMES	1	400	400#
PROCESS PANELS	10	1130	11300#
TRAVERSE LIFTER BEAM	10	70	700#
SPINDLE RAIL BRACKETS	12	$16^1/_2$	200#
PROCESS DECK BRKT'S.	12	25	300#
SPIN HOOD BRACKETS	10	5	50#
SPIN APRON BRACKETS	12	$8^1/_3$	100#
TOTAL WEIGHT WELDED STEEL PARTS			23,100#

Fig. 2—Comparative Weights of the Cast Iron and the Welded Steel Construction

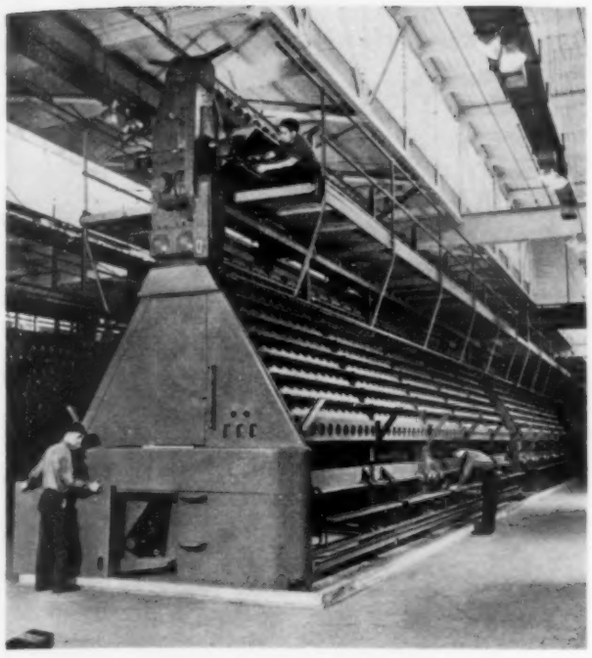


Fig. 3—Process Panel, Front Side

panels on each side to the width required by the number of the reels in a vertical line to complete the processing and drying. The width at the bottom of the panels determines the width of the cap twister.

Commissioned to design and construct 100 complete machines, each with 100 spinning and processing positions, for the parent company's new plant, the machinery subsidiary prepared frame studies and details composed of cast and machined members which conformed quite closely to prevalent textile machine frame practice.

Preference had been expressed by the parent company's officials for rugged end substantial machined cast frame members, to secure accuracy of alignment when erected. This is particularly necessary in view of the extensive amount of long line shafting for driving the various rotating parts. Further, it was expected that with many duplications in members, the castings could be machined by quantity methods and therefore produced at reasonable costs.

The design details were prepared and submitted to many responsible sources for thorough study and competitive quotations. These frame costs were so high that if this method of construction had been used the total cost of the 100 machines would have been substantially beyond the original estimate.

A further careful study of design revealed that even the most resourceful engineering and the most expert manufacture in the foundry and machine shop did not offer any possibility of reducing the total cost of these cast-iron parts by more than 25 to 30%. Since this figure was still too high to be considered, it was necessary to look to some other means for securing the frame work at a lower cost.

The drawings covering the cast-iron design were, therefore, submitted to a number of steel fabricators for their study and recommendations. They, in cooperation with the engineers of the machinery company developed several designs which were submitted with quotations.

The welded steel design presented in this paper was submitted by the American Bridge Company in competitive bidding with other designs, and was accepted in essentially the same form as herein described.

Figure 2, shows the comparative weights for cast and arc-welded construction. On the basis of the best competitive price quotations, arc-welded construction showed a cost saving of over 67%.

On the basis of this design a contract was awarded to the American Bridge Company for all the major parts.

In designing every effort was made to utilize conventional structural steel fabricating facilities for the preparation of the elements making up the completed parts, and to make use of easily obtainable, commercially rolled, structural steel sections.

It is the expectation of the purchaser that this new rayon producing machine will gradually replace existing equipment, and that the expansion of present plants or the building of new plants will require large numbers the same as, or similar to, those now being produced. Because of this prospective volume, the design is especially advantageous, as it makes easily procurable the material and facilities for rapid and economical sources of production.

The design was carefully thought out to facilitate the use of jig welding. This was of prime importance in reproducing at low costs, parts that would be interchangeable and accurate in dimensions. Moreover, since the first contract covered great numbers of like parts, heavy, rigid, permanent jigs were accurately assembled and held while being welded together. These jigs have all been used many times and will be available for future reproduction of parts after those now contracted for are completed.

The intention of the design was to avoid any machining of surfaces for accuracy after the assembly was welded together and removed from the jigs. Except in two parts the necessary accuracy was realized without resorting to machining following the welding.

Before mass production of the major parts of a machine unit was undertaken, experimental sample parts were made and carefully checked. In doing this the accuracy and efficiency of the jigs and production methods were checked.

Much skepticism was expressed as to the practicability of securing the required accuracy by jig welding methods before the experimental parts were made. Many felt that distortions caused by the welding would produce inaccuracies after the pieces were removed from the jigs, particularly in the processing panels. However, these parts have all been produced in multiple, and it has been proved in practice that the distortions caused by the welding were not of sufficient magnitude to interfere with securing the required accuracy by the methods now used.

From the experience gained on this contract it is believed that many types of machine frames and supports, hitherto thought impracticable to fabricate by utilizing welded steel construction, may now be undertaken with confidence.

Process Panel (*See Fig. 3*).—Except for the cups and the steel stampings, all elements composing the complete panel are of standard commercially rolled plates or shapes, punched, sheared, bent and sawed with a structural fabricating plant's regular equipment. The cups were blanked and formed into the shapes shown and counterbored and tapped after forming.

Extreme accuracy was required in the alignment of these cups to insure proper operation of the bevel gears driving the reel shafts, which occur at the rear of each cup on the panel. This was secured by assembling in a jig all the parts in consecutive order. Auxiliary fixtures in the jig were provided to hold all parts to accurate positions; these parts were then welded together to form

a frame from which the cups were entirely free, the cups being firmly attached to plugs in the jig base.

The accurate alignment of the cups is confirmed by a 100% inspection of the panels after completion. Special facilities were designed by the fabricator to produce a marked templet showing the exact location of the axis of each cup. With this equipment two inspectors can check a panel in thirty minutes.

Any cups which are out of alignment are removed and replaced by means of portable jigs provided for the purpose. It has been necessary to remove about 20 cups out of a total of 35,000 of record. This is not difficult to do and proves the practicability of replacement of cups that may get damaged during erection or after the machines are in operation. It was proved in most cases that the cups were misaligned because of improper attaching to the jig, and not due to distortion from the welding.

Each panel contains 356 separate parts, including nuts.

Machinery Box.—These boxes are made up of ordinary commercial plates, bars and rounds. The parts, after the preparation, were assembled in a jig and completely welded together. The welded box was then taken to a horizontal boring mill where all the boring and spot facing was done from one set-up, in order to secure the required accuracy. Small pads were machined in this same set-up in order to establish accurate gage points in a plane exactly parallel to the plane of the finished counterbore. The box, after being completely machined, is then assembled with the drive and frame, proper alignment being established by means of the machined gage pads. Each box contains 30 parts exclusive of bolts.

Drive End Frame.—The frame is made up of ordinary structural plates and shapes. The column sections were bent, milled on bottom ends and flame-cut to angle on top ends. Bearing plates were carefully pressed and straightened and jig drilled to secure the necessary accuracy.

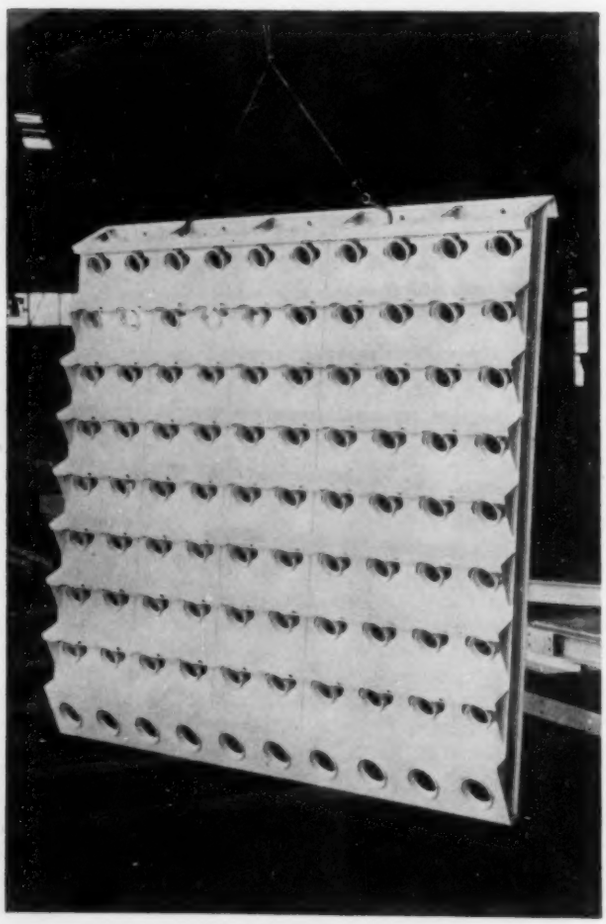


Fig. 4—Detail of Twister Traverse Table

All the parts were then assembled in a jig in which fixtures were provided for properly holding to position. The bearing plates were attached to machined pads in order to maintain the accurate relation between them and the machinery box.

The completely finished machinery box was then placed in the same jig; it being supported on machined pads in the jig, which registered with the machined bosses or pads on the box. This established the required accurate relation between the plates of the frame and the plane of the counterbore of the box.

All welding was completed before frame was removed from the jig, and no other machining or fabrication was necessary except the drilling of the holes shown in the flanges of the columns. These holes were drilled through an integral drilling templet, gaged accurately to the holes and the center line of the machine.

Each frame is made up of 13 pieces exclusive of machinery box.

Intermediate Frame.—This frame is quite similar to the end drive frame previously described. It is assembled in the same jig as was used for the end drive frame, and similar methods were employed. Each frame is made up of ordinary structural steel plates and shapes, numbering 10 exclusive of nuts.

Intermediate Spin Frame.—These frames are made up of structural steel shapes and plates, the elements being pre-fabricated and then welded in an assembling jig. No unusual methods were necessary. The frame required no machining or other fabrication after its removal from the jig. Each frame is made up of nine pieces.

Drive and Spin Frame.—The parts for these frames, made up of structural plates and bars, were pre-fabricated and welded together in a jig. Because of the accurate relations required for the connections of large mechanical units, the fabricator elected to machine the pads and the bases after the frame was removed from the jig.

Traverse Lifter Beam.—These beams comprise the two cross members for each traverse table of the cap twister, five such tables like that shown in Fig. 4 are provided on each 100-end machine.

The traverse lifter beam is made of structural shapes and two pieces of mechanical tubing for the vertical guide rod bushings. By using this accurate tubing it was possible to jig-weld all parts together, after pre-fabricating, and to avoid any drilling or boring after piece was removed from the jig.

The weight of the welded steel beam is less than one-half the weight of the corresponding cast-iron member, an important advantage in the operation of the reciprocating or traversing table for winding the bobbins of finished yarn. The five tables, 44 feet long, supporting 100 spindles and bobbins, are counter-weighted and suspended by pulleys and chains from the longitudinal rocker shafts on each side of the twister, and operated from a cam at the drive end of the machine.

Miscellaneous Parts.—These parts offer no unusual features, but are interesting adaptations of welded steel construction, making effective use of ordinary structural steel plates, bars and shapes.

All welding for all parts described by this paper was done by the shielded, manual metal-arc process, as covered by AMERICAN WELDING SOCIETY Specifications.

Comment on Welded Steel Design.—The weights in Fig. 2 include all frame members of each of the two designs which are comparable. Other items such as spin trans-

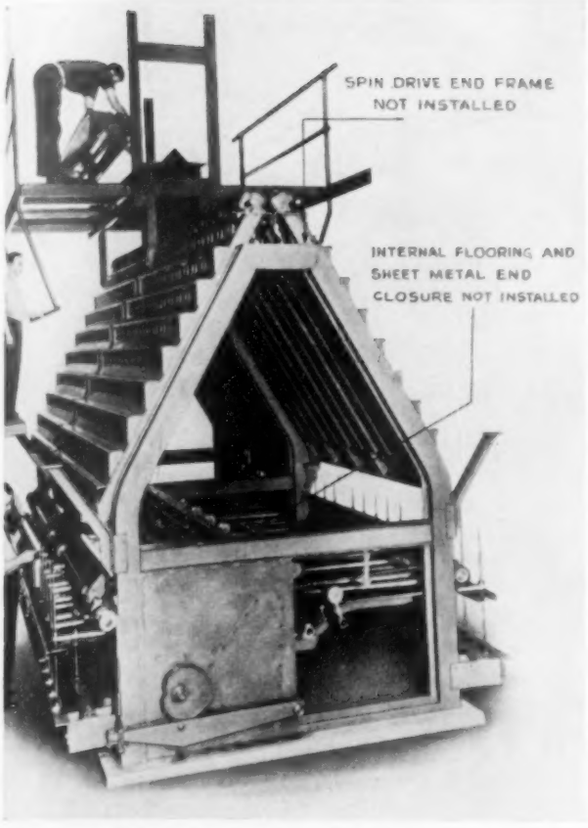


Fig. 5—Shop Assembly, Two Sections of Machine Frame

mission beams, walkways and flooring, and spin trough steel are adaptable to either the cast iron or the welded steel machine frames, and are therefore not included in any comparison.

The estimated annual production from the 100 machines is 11,000,000 lb. of finished viscose yarn. A common unit of evaluation in the industry is:

$$\frac{\text{Property, plant and equipment investment,}}{\text{Pounds of yarn produced per year}} = \text{generally from \$1.00 to \$1.10}$$

The net saving in the installed cost of equipment producing 11,000,000 lb. annually, is about 3.1% or 3.1 cents.

If, for other reasons such as processing and handling economies, improvement in quality and uniformity of product as heretofore stated, this process were in time applied to the entire viscose rayon industry, the approximate saving in first installation cost measured as above would be:

240,000,000 (estimated lb./year) × 3.1¢, or $7,440,000.

Until the large scale, commercial operation of the plant now under construction has had a reasonable length of time to demonstrate its performance, no accurate evaluation of the increased efficiency and economy of this process can be made. However, all possible cost objections to superimposing the processing units into the composite structure shown in Fig. 5 have been eliminated by the economy and simplicity of the welded frame.

Moreover, it is significant that the processing and handling expense saved, the greater uniformity and high quality of the viscose yarn produced on the pilot installation now made practical by this structure, have satisfied the parent company's management as to the soundness of their investing over eleven million dollars in the new plant to be equipped solely for this process.

The designs in welded steel were prepared by the successful bidder during May and June 1937. Contract for 100 complete machine assemblies was awarded in July 1937, and preparation of shop drawings and jigs started promptly thereafter.

Erection of the machine frames began in June 1938. Figure 5 shows assembly of two sections of machine frame. A view of one of the machines during construction is shown in Fig. 6.

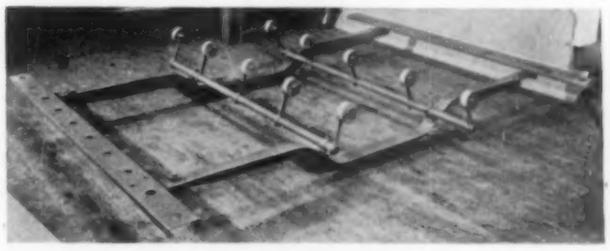


Fig. 6—One of the Arc-Welded Continuous Process Rayon Producing Machines During Construction

Flame-Shaping Grand Coulee Penstocks

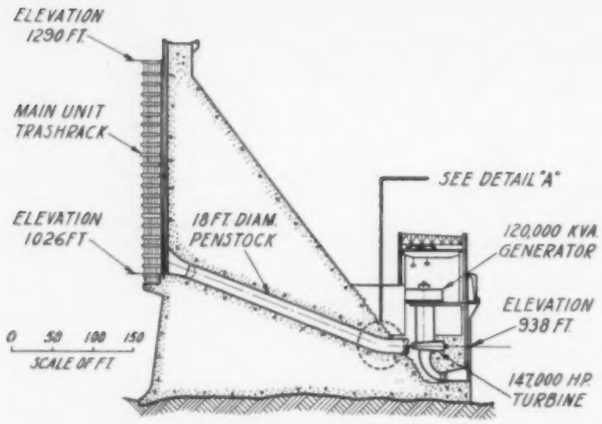
By GEORGE SYKES†

WITH the base of the dam now completed, and with work rapidly progressing on the remainder of the dam (scheduled for completion in 1942), the oxyacetylene process is proving indispensable for the fabrication of still another unit of this huge project—the 18-ft. diameter penstocks.

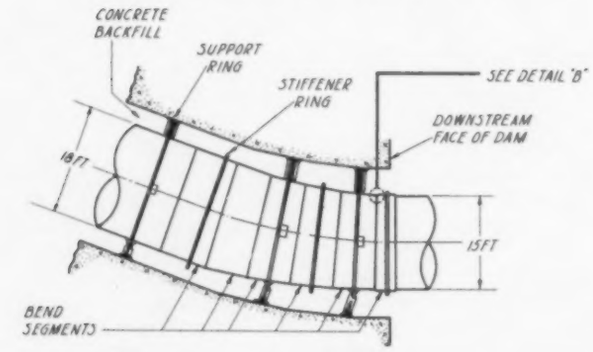
When developed to the extent proposed, the power plant will have a larger capacity than any other in the world. Eighteen main turbines are planned, each rated at 150,000 hp. under a head of 330 ft. Each power house will contain nine turbines, and each turbine will be fed by an 18-ft. diameter penstock passing through the dam. The arrow on the far bank indicates the height of the dam when completed.

All circumferential edges of segments for the reducing bends at the downstream ends of the penstocks were beveled for welding by flame-cutting. Plates were fabricated in half-sections or in plate terminology "2-plates around," then rolled into half-rounds and finally assembled by welding. The set-up for flame-cutting one of the segments at the face of the dam is illustrated, while the sketches indicate the position of this segment as well as the design of the cut edge and sequence

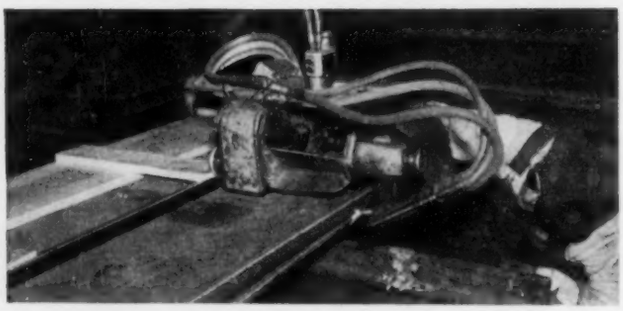
† The Linde Air Products Co., New York.



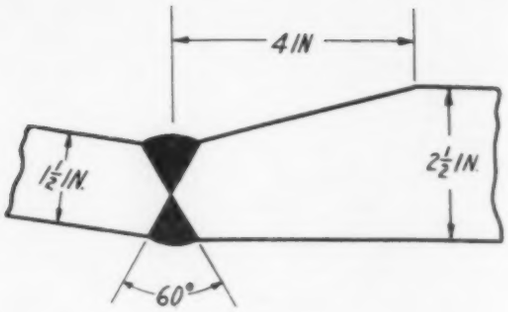
CROSS-SECTION OF GRAND COULEE DAM THROUGH ONE OF THE 18 FT. DIAMETER PENSTOCKS



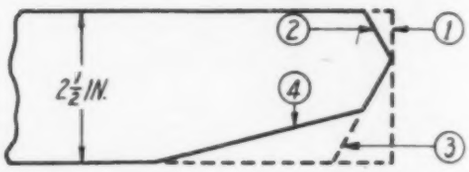
DETAIL "A"-CROSS-SECTION THROUGH REDUCING BEND AT DOWNSTREAM END OF PENSTOCK



of cutting operations. Since this particular plate is $2^1/_2$ inches thick, whereas the balance of the bend segments are $1^1/_2$ inch thick, an additional cutting operation was necessary to reduce the plate thickness 1 in. The templet for guiding the cutting machine to the correct curvature consists of a masonite track and wooden framework.



DETAIL "B"- CROSS-SECTION THROUGH DOUBLE VEE WELD BETWEEN LAST TWO BEND SEGMENTS



THE NUMBERS INDICATE SEQUENCE OF CUTS ON 2½ IN. THICK PLATE

Cutting speeds for the four operations are as follows: (1) squaring the edge—6 inches per min.; (2) top welding bevel—9 inches per min.; (3) bottom welding bevel—9 inches per min.; (4) reducing bevel—5 inches per min. In addition, all of the stiffener rings and support rings, which numbered 500 or more, were flame-cut to shape. Each of these rings consists of six welded segments, four of which can be seen in the foreground of the illustration of the completed bend segments.

CURRENT WELDING LITERATURE

Acetylene Generators. Late Advance in Acetylene Generators, G. Lottner. Eng. Progress (Jan. 1939), vol. 20, no. 1, pp. 3–8.

Agricultural Machinery. Better Hog Knives. Oxy-Acetylene Tips (Dec. 1938), vol. 17, no. 12, pp. 275–276. Flame-hardening in conjunction with flame cutting results in longer life and reduced costs.

Airplane Materials. Light Alloys for Aircraft, H. Sutton. Metal Industry (Lond.), vol. 53, no. 26 (Dec. 16, 1938) pp. 581–585, and (Dec. 30) no. 27, pp. 637–639 (discussion) 639–640.

Aluminum. Research on Welded Aluminum Alloys, E. von Rajakovics. Aluminum & Non-Ferrous Rev. (Nov. 1938), vol. 3, no. 12, pp. 421–423, and (Dec. 1938) no. 1, pp. 37–39.

Automobile Manufacture. Auto-Welding Buick Torque Tubes. Am. Mach. (Nov. 2, 1938), vol. 82, no. 22, pp. 958–959.

Bridges, Steel. Repair and Strengthening of Wrought Iron and Steel Bridges by Means of Electric Welding, H. J. L. Bruff. Structural Engr. (Nov. 1938), vol. 16, no. 11, pp. 393–399.

Cars, Freight. General American Light-Weight All-Welded Box Car. Ry. Age. (Dec. 10, 1938), vol. 105, no. 24, pp. 843–844.

Cars, Freight. Many Innovations Included in Lightweight Welded Cars. Ry. Mech. Engr. (Dec. 1938), vol. 112, no. 12, pp. 468–472.

Cars, Freight. Milwaukee All-Welded Flat Cars. Ry. Age. (Dec. 17, 1938), vol. 105, no. 25, pp. 872–873.

Cars, Freight. Welded Box and Refrigerator Cars. Ry. Age (Nov. 5, 1938), vol. 105, no. 19, pp. 654–658.

Cars, Passenger. Light Weight Passenger Coach Frame, A. E. Katz. Can. Metals & Met. Industries (Nov. 1938), vol. 1, no. 11, pp. 295–298.

Copper Welding. Long Carbon Arc Welding of Copper and Copper Alloys, W. C. Swift. Welding Engr. (Dec. 1938), vol. 23, no. 12, pp. 30–33.

Electric Welding, Arc. Atomic Hydrogen Arc Welding—How to Use Process, J. W. MacFarlane. Sheet Metal Industries (Jan. 1939), vol. 13, no. 141, pp. 89–90 and 98.

Electric Welding, Arc. Cost of Welding and Welded Products Factors Involved Economics, E. W. P. Smith. Sheet Metal Worker (Dec. 1938), vol. 29, no. 12, pp. 23–25 and vol. 30, no. 1 (Jan. 1939) pp. 68–70.

Electric Welding, Arc. Organization, Equipment and Operation of Plant Weldery, H. Thompson. Elec. News (Dec. 15, 1938), vol. 47, no. 24, pp. 32–33.

Electric Welding, Arc. Quantitative Considerations of Electric Welding, J. ter Berg. Philips Tech. Rev. (Dec. 1938), vol. 3, no. 12, pp. 352–355.

Electric Welding, Arc. Reliability of Finished Product Claimed for Union Melt Automatic Welding, C. R. Whittemore. Can. Machy. (Dec. 1938), vol. 49, no. 12, pp. 222, 224 and 226.

Electric Welding, Arc. Technique of Arc Welding, R. Owens. Welding Engineer (Dec. 1938), vol. 23, no. 12, pp. 34–35, and vol. 24, no. 1 (Jan. 1939) pp. 30–32.

Electric Welding. Electrode Alloys for Welding Small Contacts, E. E. Halls. Aluminum & Non-Ferrous Rev. (Oct. 1938), vol. 3, no. 11, pp. 391–393.

Electric Welding, Foundries. Use of Electric Welding Plant in Steel Foundry, V. G. Pearson. Foundry Trade J. (Dec. 15, 1938), vol. 59, no. 1165, pp. 448–449 (discussion) pp. 449–450.

Electric Welding, Resistance. Recent Advances in Resistance Welding, L. B. Hunt. Metal Industry (Lond.), vol. 54, no. 2 (Jan. 13, 1939) pp. 69–73.

Electric Welding, Resistance. Spot-Welding Aluminum, F. C. Pyne. Western Flying (Jan. 1939), vol. 19, no. 1, pp. 10–13.

Girders, Welded Steel. Box Girders. Steel (Aug. 1, 1938), vol. 103, no. 5, pp. 51–53.

Girders, Welded Steel. Scale-Model Structure Tests with Particular Reference to All-Welded Plate Girders, H. E. L. Martin. Structural Engr. (Nov. 1938), vol. 16, no. 11, pp. 338–358.

Metals, Hard Facing. Design and Preparation of Parts for Hard Facing Applications, E. E. LeVan. Welding Engr. (Dec. 1938), vol. 23, no. 12, pp. 17–18.

Metals, Hard Facing. Hard-Facing Reduces Maintenance, R. K. Kennedy. Paper Industry & Paper World (Sept. 1938), vol. 20, no. 6, pp. 634–636.

Metals, Hard Facing. Longer Life for Steel Producing and Fabricating Equipment. Oxy-Acetylene Tips (Dec. 1938), vol. 17, no. 12, pp. 269–274.

Motor Cycle Engines. Added Service-Years. Oxacetylene Tips (Dec. 1938), vol. 17, no. 12, p. 279. Broken motorcycle engine is successfuly repaired by aluminum welding.

Oxyacetylene Cutting. Suitability of Flame-Cut Surfaces for Welding, C. W. Obert. Engineering (Oct. 28, 1938), vol. 146, no. 3798, p. 521.

Oxyacetylene Welding. Flame-cut Shapes and Arc Welding Are Cutting Fabrication Costs, III. Welding Engr. (Dec. 1938), vol. 23, no. 12, pp. 22–25.

Oxyacetylene Welding, R. H. Kehl, rev. by M. H. Potter. Chicago, American Technical Society, 1939. 130 pp., illus., diagrs., tables, $1.25.

Oxyacetylene Welding. Reconditioning of Warm Metal Surfaces by Oxy-Acetylene Welding. Engineering (Oct. 21, 1938), vol. 146, no. 3797, pp. 490–491.

Petroleum Cracking Plants. Large Tube Savings by Welding on 2-Ft. End Sections, A. S. James. Nat. Petroleum News (July 27, 1938), vol. 30, no. 30, pp. R347–348.

Petroleum Pipe Lines. Welding Processes Are Vitally Important in Oil Field Production. Welding Engr. (Jan. 1939), vol. 24, no. 1, pp. 15–19.

Pipe Lines. Pipe Welding Costs and Data, A. F. Davis. Power Plant Eng. (July 1938), vol. 42, no. 7, pp. 468–469.

Pipe Mills. Continuous Pipe Mill. Steel (Aug. 1, 1938), vol. 103, no. 5, pp. 40 and 42.

Pipe, Steel. Investigation of Stress Conditions in Full-Size Welded Branch Connection, F. L. Everett and A. McCutchen. Am. Soc. Mech. Engrs. Trans. (Feb. 1939), vol. 61, no. 2, sec. 1, pp. 167–176.

Poles, Wooden. More Poles Per Day. Oxy-Acetylene Tips (Dec. 1938), vol. 17, no. 12, p. 277. Air-acetylene flame proves ideal source of heat for heating telephone pole branding irons.

Railroad Signals and Signaling. Committee IV—Automatic Block Signaling. Assn. Am. Railroads—Proc. (Signal Sec.), vol. 36, no. 1, mtg. Mar. 13 and 14, 1939, pp. 65–96. Requisites for track welding.

Rails, Oxyacetylene Welding. Building-Up Rail Ends with Multiple-Flame Torches. Ry. Eng. & Maintenance (Aug. 1938), vol. 34, no. 8, pp. 476–479 and 483.

Rails. How Prolong Life of Rails? C. B. Bronson. Int. Ry. Congress Assn.—Bul. (Dec. 1938), vol. 29, no. 12, pp. 1209–1212.

Riveting Machines. Welded Riveting Machine, J. M. Baxter. Mech. World (Dec. 30, 1938), vol. 104, no. 2713, pp. 634–635 and 637.

Saws, Welding of. Aluminum & Non-Ferrous Rev. (Sept. 1938), vol. 3, no. 10, pp. 357–358 and 380.

Shipbuilding. Electric Arc Welding During 1938. Shipbldg. & Shipg. Rec. (Special No.) Dec. 30, 1938, pp. 18–20.

Shipbuilding, Electric Welding. From Channel Beams to Completed Motorship. Motorship (Jan. 1939), vol. 24, no. 1, pp. 10–11.

Shipbuilding. How Industry Has Helped in Shipbuilding and Marine Engineering, J. W. Donaldson. Foundry Trade J. (Jan. 12, 1939), vol. 60, no. 1169, pp. 31–32.

Shipbuilding in United States and Abroad During 1938. Nat. Council Am. Shipbldrs. Bul. (Jan. 3, 1939), no. 513, 7 pp., 6 supp. sheets.

Soldering. Progress in Soldering and Brazing, C. L. G. Ashby. Metal Industry (Lond.), vol. 54, no. 2 (Jan. 13, 1939) pp. 77–81.

Stainless Steel. Best Techniques to Employ in Stainless Steel Welding, V. W. Whitmer. Welding Engr. (July 1938), vol. 23, no. 7, pp. 18–20.

Steel Hardening. Oxy-Acetylene Surface-Hardening, A. K. Seeman. Can. Metals & Met. Industries (Nov. 1938), vol. 1, no. 11, pp. 306–307, and (Dec.) no. 12, pp. 329–333.

Steel, Hard Facing. Opportunities Presented to Experienced Welding Men in Flame Hardening Applications, J. Sheppard. Welding Engr. (Jan. 1939), vol. 24, no. 1, pp. 21–24.

Steel Plates. Welding Data to Help Fabricator Using Nickel-Clad Steel, F. P. Huston and T. T. Watson. Welding Engr. (Dec. 1938), vol. 23, no. 12, pp. 19–21 and (Jan. 1939), vol. 24, no. 1, pp. 25–28.

Strip Steel. Continuous Pickling of Wide Strip Steel with Flash Welding, L. R. Milburn. Iron & Steel Engr. (Nov. 1938), vol. 15, no. 11, pp. 32–42; (discussion) pp. 42–43.

Structural Steel. Investigation into Behavior of Welded Rigid Flame Structures, J. F. Baker and J. W. Roderick. Inst. Welding Trans. (Oct. 1938), vol. 1, no. 4, pp. 206–226.

Tube Mills. Electrical Equipment of Modern Steel Tube Plant, Engineering. (Oct. 21, 1938), vol. 146, no. 3797, pp. 469–471 and 478.

Welded Steel Structures. Regulations and Specifications for Welded Steelwork, E. P. S. Gardner. Structural Engr. (Dec. 1938), vol. 16, no. 12, pp. 471–483.

Welded Steel Structures. Welded Steel Construction, R. S. Hale. New York and Chicago, Pitman Publishing Corp., 1938. 170 pp., illus., diagrs., charts, tables, $3.00.

Welding Encyclopedia. 1938. Compiled and edited by L. B. Mackenzie and H. S. Card. 9th Edition. Chicago, Welding Engineer Publishing Co., 696 pp., illus., diagrs., charts, tables, $5.00.

Welding. Commercial Weldery, A. E. Gibson and M. W. Gibson. Am. Mach. (Nov. 16, 1938), vol. 82, no. 23, pp. 1002–1005.

Welding Rods. Drying of Coated Welding Rods. Engineering (Nov. 25, 1938), vol. 146, no. 3802, pp. 613 and 618.

Welding Non-Ferrous Metals. Fusion-Welding Non-Ferrous Metals, H. W. G. Hignett. Metal Industry (Lond.), vol. 54, no. 2 (Jan. 13, 1939) pp. 74–76.

Welding in Europe and America, C. H. Jennings. Sheet Metal Industries (Jan. 1939), vol. 13, no. 141, pp. 93–95.

Welding Problems and Progress, W. Larke. Inst. Welding Trans. (Oct. 1938), vol. 1, no. 4, pp. 200–205.

Welding Shops. Organizing, Equipping and Operating Plant Weldery, H. Thomasson. Can. Machy. (Nov. 1938), vol. 49, no. 11, pp. 47–48. (Dec. 1938) no. 12, pp. 226 and 228.

Welding Shops. Welding Only. Am. Mach. (Nov. 30, 1938), vol. 82, no. 24, pp. 1057–1060.

Welding Steel. Recommended Welding Procedure for High-Carbon Steels, E. W. P. Smith. Welding Engr. (Jan. 1939), vol. 24, no. 1, pp. 28–29.

Welds Cracking. Causes of Cracked Welds, C. Stieler. Can. Metals & Met. Industries (Dec. 1938), vol. 1, no. 12, pp. 326–328.

Welds Design. Spot Welded Joints: Data and Procedure for Their Design in Various Metals, L. H. Frost. Product Eng. (Jan. 1939), vol. 10, no. 1, pp. 15–18.

ELIMINATION OF RAIL JOINTS from Steam and Electric Railway Track by Arc Welding

By D. B. HUNT*

IN THE past few years the welding of rail joints together to create long continuous lengths of jointless track has passed out of the experimental stage and is receiving serious attention by engineers of practically all railroad systems. Some of the major railway systems have already done a considerable amount of this work and their plans are to increase the work each year.

It was stated in *Railway Age*, a railway publication, that more than $450,000,000 was spent in 1936 for maintenance of way. In order to show what tremendous maintenance expense rail joints are to railroads, the following is quoted from an article by Mr. L. A. Downs, President, Illinois Central System in the January issue of *Railway Engineering and Maintenance:*

"Fully 50 per cent of the expense of track maintenance is incurred at the rail joints. The same stresses which cause the rail to wear at the ends also cause the fastenings to work loose and the ballast to be disturbed. Anything that is done to lessen the number of joints makes for permanent economy in track maintenance and produces a collateral saving by reducing the shocks on the rolling stock equipment. One thing that has been done has been to lengthen the standard rail from 33 ft. to 39 ft., reducing the number of joints in the track by 18 per cent. Another thing that has been done has been to weld into a single piece long stretches of rail in crossings, on bridges, in tunnels and elsewhere. This has been done experimentally on stretches up to one mile in length, with such success as to hold promise of additional permanent economies in the future."

Other prominent railway engineers of this country agree with Mr. Downs of the Illinois Central System, that the next great step in advancement of the railroads from an engineering and general improvement standpoint, lies in the elimination of the expensive rail joint. A large percentage of the $450,000,000 spent for track maintenance by the railroads of this country in 1936 could have been saved through long continuous lengths of welded jointless track, and a large percentage of this will be saved in the future by welded rail. A large saving in repairs to rolling stock equipment, also will be saved as the result of rail welded together.

Some of the advantages of long continuous lengths of rail welded together are as follows:

1. Saving in rail replacement due to longer life of the rail because of the fact that after welding there will be no rail ends to wear and batter under traffic.
2. Saving in labor and material on refinishing joints, repairing and replacing ties and building up ballast to keep level surfaces.
3. Lower maintenance cost of rolling stock equipment as there is less hammering and batter to this equipment caused by joints.
4. Smoother riding conditions, which also mean added safety.
5. Less damage to freight because of the smoother track resulting in appreciably lower freight claims.

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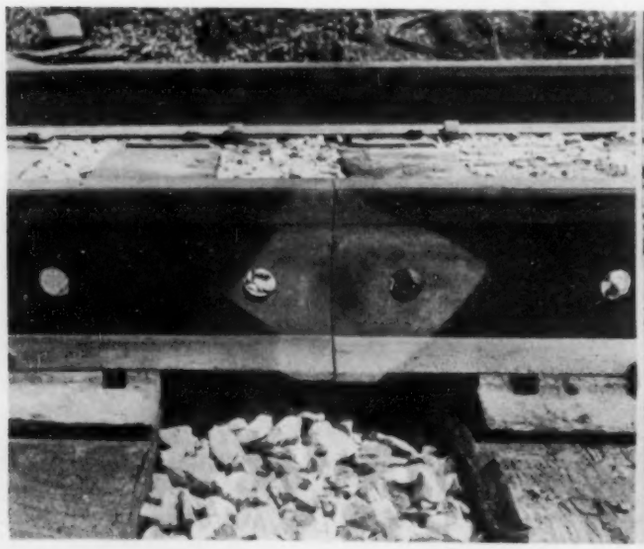


Fig. 1—Joint Lined Up and Ready for Preheating

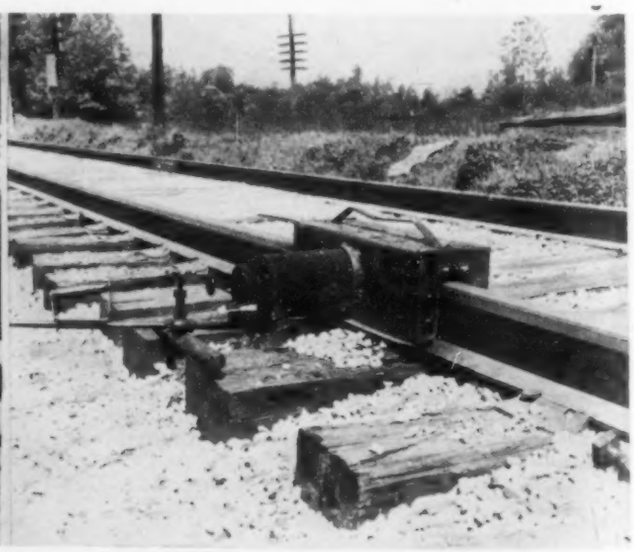


Fig. 2—Joint Being Heated by Preheating Hood

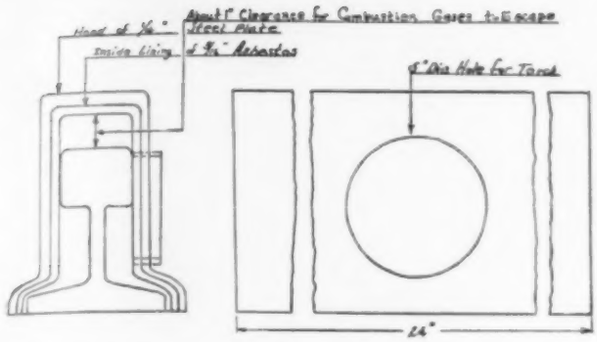


Fig. 3—Preheating Hood

6. Elimination of signal circuits and bond wires, resulting in more efficient signal system.

7. Rail creepage eliminated, which will result in better line and surface. Higher train speeds can be obtained.

It is impracticable to accurately estimate the possible yearly savings which would accrue from elimination of rail joints, but railway engineering authorities know that the ultimate savings would be great.

Up to the present time the methods used to weld rail joints are the "Thermit Welding" and "Electric Flash Welding" methods. Both of these methods have proved practical and very successful.

We have made more than 600 electric welds, welding rail together in long continuous lengths on the Southern Railway. These welds were made in the past four years and they are all over one year in service and the majority as much as three years. These welds have proved satisfactory in every respect under operating conditions. Practically all of the welds were made in track under traffic without interruption of train service. The men in charge of track where this work was done are: Mr. W. P. Mills, Supervisor, Salisbury, N. C., Mr. G. C. Smith, Roadmaster, Greensboro, N. C. and Mr. C. W. Russell, Roadmaster, Greenville, S. C.

These men claim that the maintenance cost where the welds were made has been appreciably less for a given period of time as compared with another equal period of time before welding the joints.

PREPARATION OF RAILS FOR WELDING

The following is a description and explanation, including sketches and photographs of the D. B. Hunt Method of electric welding rails together.

The first operation in the electric welding of rails together under this method is the work of a section force of two men. This section force or trackmen tamp up the ties, if they are either swinging or are low and they do the necessary lining and gaging of the track, thereby putting in perfect horizontal and vertical alignment the rails, which are to be welded together. The two trackmen then remove the conventional type angle bars, which hold the two rail ends together and in alignment.

The welder helper then removes all rust, scale, etc. from the area to be welded (see Fig. 1). This is accomplished with a wire brush and a portable electric grinder.

After all rust is removed, the welder helper then applies an asbestos lined hood over the rails (see Figs. 2 and 3). The preheating hood is shaped to fit closely around the rail. There is a hole in the middle of the hood, as is shown, for the flame of the kerosene torch. The two rail ends are preheated to 800° F. to take the chill out of the steel and to prepare the steel for the cutting (chamfering Fig. 4.) and welding operation. A hand pyrometer is used to determine the heat in the steel. The preheating operation prevents sudden change of temperature of the steel and results in a good weld free of embrittlement and hard zones.

When the chamfering or cutting operation is to be done by means of heat, such as the electric arc or acetylene torch, it is preferable to preheat the ends of the rail by a suitable preheating device, such as a kerosene, or gasoline or an oil torch shown in Fig. 2. This allows the cold rail steel to be nearer an equilibrium state from a metallurgical standpoint. It helps to prevent microscopic cracks caused by expansion and contraction.

If the chamfering or cutting operation is accomplished with a friction saw or by mechanical means other than the electric arc or acetylene torch, then the preheating is not necessary.

After all the chamfering or cutting operation is finished, all scale, loose or foreign matter is removed, so that a clean welding surface is assured. This cleaning operation can be accomplished with a wire brush, chisel and abrasive grinding wheel.

Welding Procedure

Preheat to approximately 900° F. After all of the chamfering and cutting work is completed and the two rail ends are in true line and surface, and all scale and rust or foreign matter has been removed from the area to be welded, the two rail ends are then ready for the welding operation.

Base Section—Square Open Joint

The welder operator starts the weld in the base section. If the gap or space between the two edges of the base section is of such width to cause the welder difficulty in starting the weld in the base because of the molten metal dropping through, the welder places a copper bar on the under or bottom side of the base, which helps to hold the molten metal up in the welded area. The weld metal does not adhere to, nor does it weld the copper bar to the base section. After the first weld section is put in the base section, the copper bar is removed by merely tapping by light blows from a hammer. The welder operator can then continue the welding of the base section.

Another alternative to the use of the copper bar on the base section, is the use of a mild steel backing-up

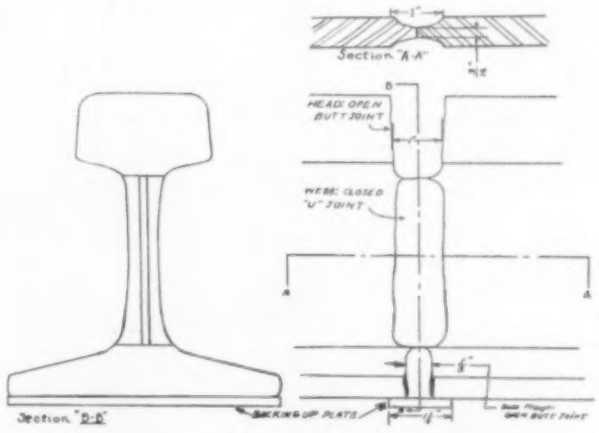


Fig. 4—Joint Completely Chamferred and Ready for Welding. Before Welding Is Started Joint Is Again Heated to 900° F.

plate. This mild steel plate is applied to the bottom side in the same manner as the copper plate, except, that the mild steel plate is welded to the bottom side of the base section. The weld that bonds or ties the base section together also welds the mild steel plate to the base section. The approximate size of this mild steel plate is $^3/_{16}$ inch thick, 1 inch wide and the length to be equal to the width of the base of the rail. This would completely cover the gap between the two rail ends on the bottom side where they are chamfered.

Figure 5 shows a cross-sectional or end view of a rail, and it is laid off in sections and sub-sections, thus: Section 1, *A*, *B*, *E*, *F*, *I*, etc., also Section 2, *C*, *D*, *G*, *H*, *J*, etc. Also their lines identified as: "*Z*1 and *Z*2."

These sections, sub-sections and lines are shown so as to guide the welder operator in the step-by-step welding procedure as follows:

The welder begins the first welding operation at the point where Line 1 intersects with "A," the signs or symbols: thus "⊃" means that the direction of welding is from right to left, and thus: "⊂," etc., means that the direction of welding movement is from left to right. The welder starts at Line 1*A* and welds to Line *Z*1, then back to Line 1 again, thereby forming welds "A" and "B," after cleaning flux and scale from weld and after hammering weld to relieve stresses, he again starts weld at Line 1 where "A" was started, and welds from left to right, making weld "C," he then moves back on weld "C" from right to left to complete weld "D." Welds "D" and "C" are now a part of welds "A" and "B."

This is the first completed welded sub-section of the base. The remainder of the base is completed in the same manner until Sections 1 and 2 are completed. After each two sub-sections are completed, the beads or welds are hammered and cleaned as heretofore explained.

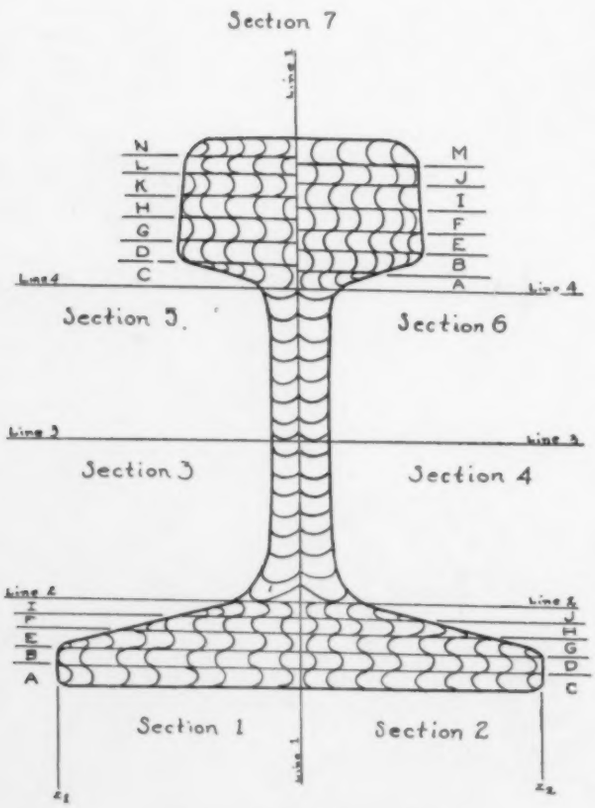


Fig. 5—Cross Sectional View of Rail

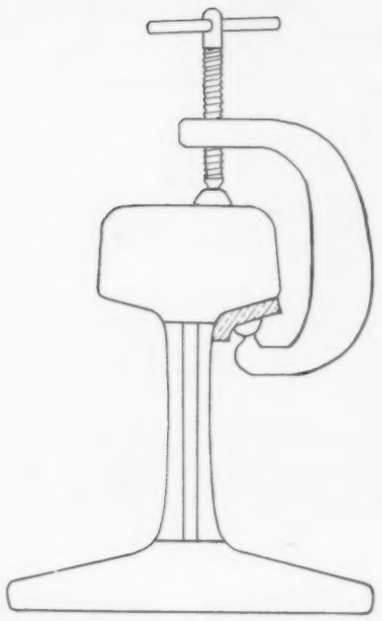


Fig. 6—Copper Bar as an Aid to Welding Head Seam

After Sections 1 and 2 are completed, this would mean that the base section has been completed, the welder is then ready to weld the web section. Sections 3, 4, 5 and 6 are not subdivided as are Sections 1, 2 and 7, because there is only 1 bead or weld on each side of the web.

Web Section—Closed "U" Joint

The weld in the web is made as follows:

The welder starts at a point where Lines 1 and 2 intersect and welds upwardly or vertically on one side of the web to a point halfway of the web. This would be to where Lines 1 and 3 intersect on the drawing. The hot metal is hammered to relieve shrinkage stresses. The welder then moves back on the opposite side of the web at a point where Line 1 intersects with Line 2, the welder then completes the weld on this side up to a point halfway of the web, or where Lines 1 and 3 intersect. The weld is then hammered to relieve stresses.

The web is now welded one-half way up.

Sections 5 and 6 are done in the same manner until the entire web has been welded up to the bottom side of the head of the rail, or to where Lines 1 and 4 intersect on the drawing.

Head Section—Square Open Joint

The head section is now ready for welding, and is started by placing a copper bar, approximately $^1/_4$ inch thick, which is bent and shaped to fit the contour of the bottom side of the head, under the bottom side of the rail head to act as a backing-up plate while the first layer of metal is applied in the head section. The copper bar is of sufficient width and length to cover the gap between the two heads of the two rails (see Fig. 6).

The welder starts weld "A" in Section 7 where Line 1 intersects with Line 4. The welder makes weld "A" from left to right. He moves back on weld "A" from right to left to make weld "B." Flux is removed, the weld hammered and the copper backing plate is then moved and placed on the opposite side where welds "C" and "D" are made. The welder starts weld "C" at a point where weld "A" was started, that is, at the point where Lines 1 and 4 intersect. Weld "C" ties in with

Fig. 7—Joint Welded in Base and One-Half Way Up on Web

Fig. 8—Joint Completely Welded and Built Back on Worn Area to Take Care of the Battered Area

weld "A" and runs from right to left. The welder moves back on top of weld "C" to make weld "D."

After welds "C" and "D" are completed, welds "E" and "F" are made and the remainder of the head section is completed according to the steps shown alphabetically until the entire head section is welded. It would only be natural that any one would question why the rail was welded in this step-by-step method. The reason for this is that the writer developed this procedure of welding as being the one having the least residual stress in the weld after it was completed and also, the one by which the welder would have the least flux inclusion.

It should be observed that when two sub-sections are made, that is, for example "A" and "B," these two beads or layers of metal are slightly lower in elevation than sub-section "C" and "D." Sub-section "C" and "D" is made higher than "A" and "B" to allow the hot molten flux to run off better. Sub-section "E" and "F" is then made slightly higher than "C" and "D" for the same reason. This is not highly important, but it is a useful and helpful procedure to keep the molten flux from becoming too heavy on top of each weld.

It is not compulsory that the welder follow these step-by-step movements or procedure exactly as stated. The welder could reverse the steps and achieve the same results. Individual welders sometimes desire to weld in different directions or positions and some change in the step-by-step procedure shown in Fig. 5 is permissible. However, the design of the welds shown here should be followed generally.

If used or old rail is being welded, and if the ends of such rail are battered down from impact, and if such battered ends have not been cut off then it is necessary for the welder to build back on the battered rail ends to restore the metal in the depressed area to a true and level surface. Fig. 8 shows a rail built back on the rail surface to restore the battered area. If new rail is welded, this would not be necessary. After the head section has been completely welded, it is hammered vigorously to relieve any shrinkage stresses.

Postheating—Normalizing Operation

After all the welding is completed, the postheating and normalizing operation follows. The same hood that was used for the preheating operation is used, and the welded section is postheated to 1450° F. This is 100° F. above the critical point temperature. A hand pyrometer with a temperature range of from 0 to 2000° F., is used to insure accuracy in temperature reading.

After the temperature is brought up, this preheating hood is then replaced with the normalizing hood. This normalizing hood is shown on Figs. 9 and 10. After the normalizing hood is placed around the hot welded joint, it is filled with ground asbestos. This asbestos completely envelops the heated area and is left on the heated portion until the temperature has slowly cooled down to 100° F. or less.

The final operation consists of grinding and surfacing the welded section on top of the rail. This is accomplished with a portable electric grinder, which is powered from the welding outfit, or a flexible shaft cup wheel grinder powered by a small gasoline engine (see Figs. 11 and 12).

In the past seven years, I have given considerable time experimenting on this type of welded joint. I have found that by carefully adhering to the above procedure and using care in the actual welding, good strong welds, which are not brittle and too hard will result. I arrived at the preheating and normalizing temperatures by making many laboratory experiments regarding annealing and normalizing, and obtained my best results with the temperatures given above. The success that I have had with these joints is the result of painstaking and careful metallurgical research work in the laboratory.

The preheating and normalizing are very important parts of the operation, and too much emphasis cannot be put on being careful with this part of the job.

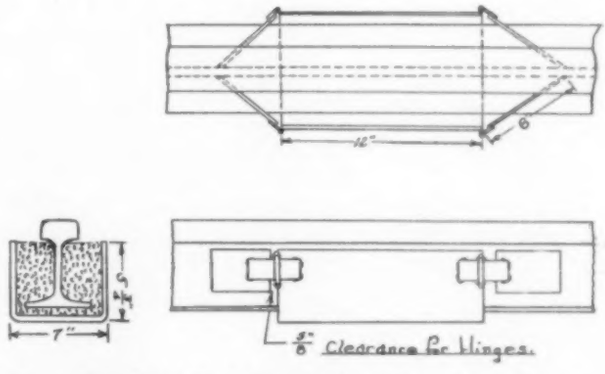
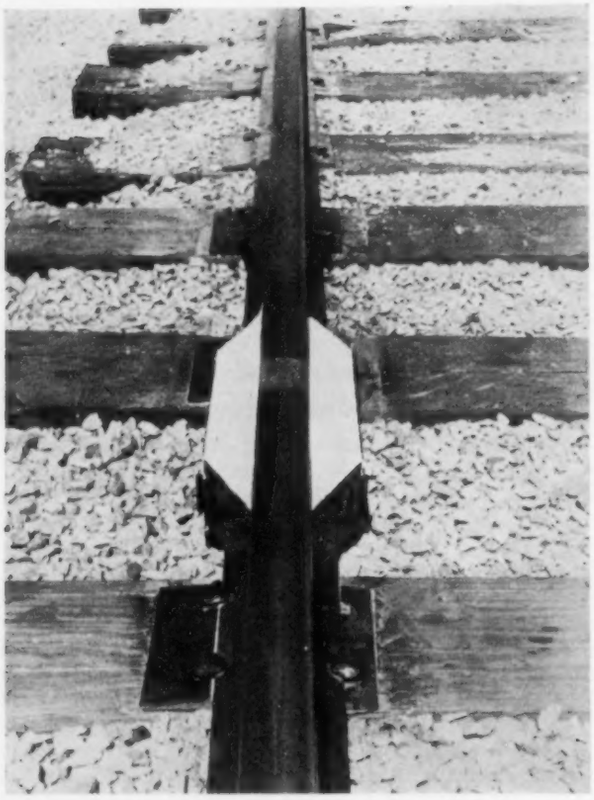


Fig. 9—Normalizing Hood, Cross-Sectional View, Showing How the Asbestos Envelops the Rail



Following are locations where some of the rail joints were welded in 1936 on Southern Railway tracks (see Fig. 13).

Salisbury, N. C., 215—100 lb. A. R. E. A. rail joints welded @ $4.977

China Grove, N. C., 60—100 lb. A. R. E. A. rail joints welded @ $5.09

Landis, N. C., 69—100 lb. A. R. E. A. rail joints welded @ $5.39

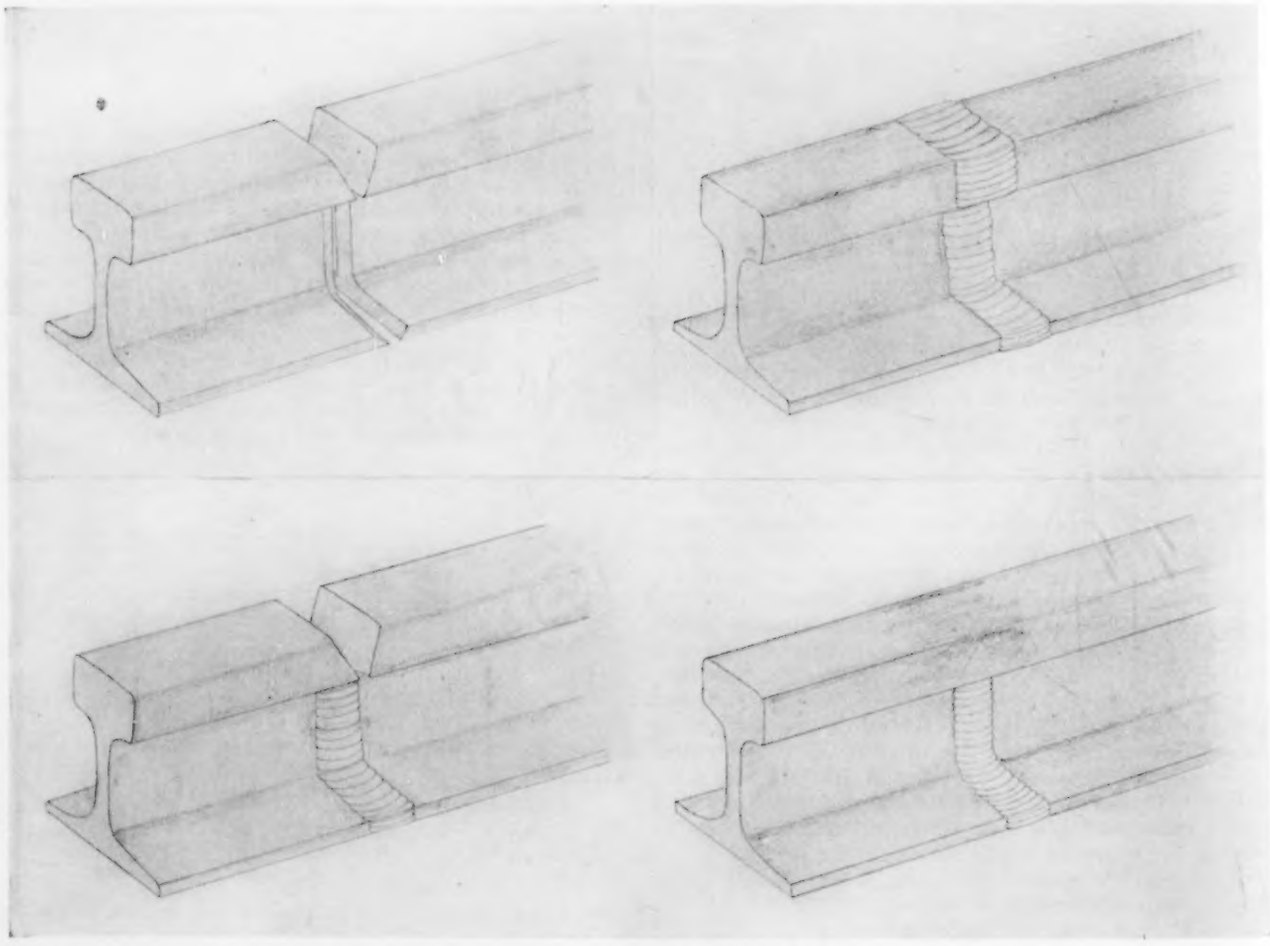
Kannapolis, N. C., 38—100 lb. A. R. E. A. rail joints welded @ $4.745

Concord, N. C., 96—100 lb. A. R. E. A. rail joints welded @ $5.19

After two years service this work is still satisfactory. Mr. W. P. Mills, Supervisor of Track at Salisbury, N. C. and Mr. G. C. Smith, Roadmaster at Greensboro, N. C., claim that their maintenance cost where the welded sections are located, have been materially reduced and that the track where the joints are located has required practically no attention since the work was done. It is the prediction of this writer that in the future all new rail will be welded, and preferably with the electric arc method, described in this article, because the rail can be laid, lined and surfaced to the natural contour of the road bed and then welded in track. This is an important feature. Also, the rail can be welded without interruption of train service.

Fig. 10 (Left)—Normalizing Hood, Horizontal View, Showing How the Hood Fits Along the Base, Web and Head

Fig. 11 (Below)—Sketches Showing Procedure in Arc Welding Rail Joint



From the time the last work was done, the writer has considerably improved the technique and procedure of the work and this has reflected in reduction of the cost, as based on the original work and it is expected that further improvement will be made. The writer is constantly making laboratory tests to determine physical and chemical analysis of welding rods and their adaptability for the rail welding. Heat treatment determinations are also included in the laboratory, as well as in the field tests.

Analysis of Cost of Welding Rail With the Hunt Electric Arc Method

Job No. 1 for Southern Railway Company at Kannapolis, N. C.

124.00 lb.	of welding rod	$20.39
16.00 "	" backing-up mild steel plate	.88
4.00 gal.	" lubricating oil	2.12
63.00 "	" fuel oil for engine	3.62
2.00	emery wheels	3.44
	Total	$ 30.45
40 hours of labor for two welders, one grinderman, supervision, depreciation and obsolescence for equipment		149.88
		$180.33

38 joints welded—total cost per joint for the Kannapolis, N. C., joint work, $4.745

Job No. 2 for Southern Railway Company at Landis, N. C.

303.00 lb.	of welding rod	$49.81
31.00 "	" backing-up mild steel plate	1.71
4.00 gal.	" lubricating oil	2.39
135.00 "	" fuel oil for engine	7.76
4.00	emery wheels	6.88
	Total	68.55
81 hours of labor for two welders, one grinderman, supervision, depreciation and obsolescence for equipment		303.51
		$372.06

69 joints welded—total cost per joint for the Landis, N. C. joint work, $5.39.

The reason for the difference in cost of these two jobs was that some time was lost in moving the equipment from Kannapolis, N. C. to Landis, N. C. Working under a regular setup or a rail welding program, there would be less loss of time, and so on, because provision would be made to eliminate long jumps of the equipment from one station to another, as was experienced in this case.

WELDING RAIL THAT HAS BEEN "CROPPED" OR CUT OFF AT THE ENDS BECAUSE OF BATTER

When used rail that has been punched or drilled in the web section for angle bar or fishing plate bolts is welded, it is desirable sometimes, depending on the degree of batter, to cut off a section of each end of the rail before welding.

After considerable use, the rail ends hammer or batter down on the ends from wheel impact. This wheel impact creates an uneven surface on the top of the rail. By cutting off a certain section of the end of the rail, this battered or uneven surface is eliminated and a true even surface is obtained between the two rail sections. The amount of length of rail to be cut off depends on the degree of batter on the rail end and the length of time the rail has been in service. In the standard rail, there are two holes in each end, the first hole is $1^{13}/_{16}$ inches from the end of the rail. The second hole is 7 inches from the first hole, or $8^{13}/_{16}$ inches from the end. In some cases, it is desirable to cut off a section of rail, the point of cut or severance to be at a point approximately one-half way between the first hole and the second hole; and in some cases it is desirable to cut off the rail behind the second or last hole, or approximately 10 inches from the end of the rail. The amount to be cut off can be determined by the use of a "straight edge," or a suitable instrument for gaging level surfaces. The person in charge of the track, welding operator or engineer in charge of track can determine when it is desirable to cut off and the amount to be cut off the end of the rail to obtain a true level surface of the rail ends.

When it is desirable not to cut off a section of rail, when such rail is battered or has an unlevel surface, then the welder operator restores or builds up with the weld metal the battered or depressed section of rail until such section is level and true with the other level surfaces of the rail.

If, and when it is desirable to cut off certain sections of the rail end to eliminate the battered or depressed surface, the same general chamfering or cutting operations are followed as referred to as heretofore.

Fig. 12—The Completed Welded Joint, Finished, Ground, Etc.

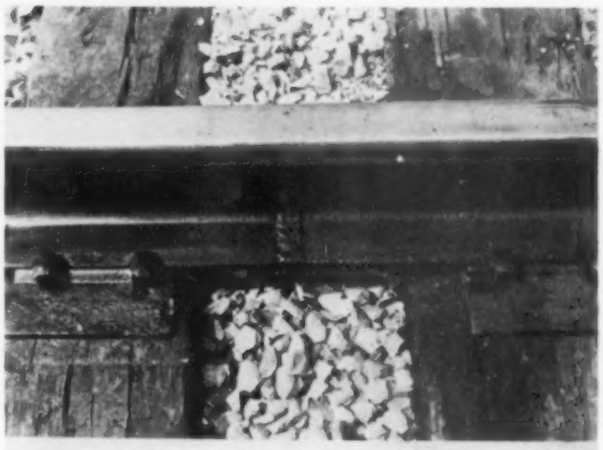


Fig. 13—Electric Welded Track at Alexandria, Va.

MAKING DOUBLE SHOULDERED TIE PLATES OUT OF SINGLE SHOULDERED TIE PLATES

When rail joints are welded together for any reasonable length, it is desirable to use double shouldered tie plates to prevent any possible lateral or buckling out movement of the rail. These double shouldered tie plates can be procured from steel manufacturers equipped to furnish them. However, very few railways are equipped with double shouldered tie plates. With the advent of long

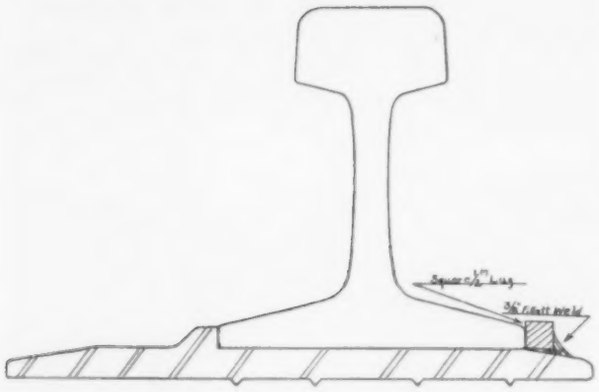


Fig. 14—Detail of Welding Lug on Tie Plate to Make Double Shouldered Plate

lengths of welded track, it has become evident that the double shouldered plate would be needed. As stated before, the railways generally are not equipped with these double shouldered plates, but are equipped with the standard single shouldered tie plate. The single shouldered tie plate consists of one shoulder on the outside, but no shoulder on the inside (see Fig. 14). The spikes, which are driven through a hole that has been punched in the plate, serve to hold the rail in line on the inside, when single shouldered plates are used.

In order to utilize the present single shouldered plate in use today, the writer has invented a method, along with the welding rail joints together, to make double shouldered tie plates out of the single shouldered tie plates. It is described as follows: A piece of square iron or steel, hot rolled mild steel grade, the width and height of which should be equal to the thickness or depth of the base of the rail at the point where the shoulder is located, is used. The length of this square piece of iron or steel should be equal to the distance of the space or gap between the spike holes in the tie plate. Some tie plates are punched on the inside with two spike holes and some with three spike holes. As an example, some 100-lb. A. R. E. A. tie plates are punched so that they can be used for 85-lb. rail. Such tie plates would have three holes, one hole for a spike when using 85-lb. rail and two holes for spikes when using 100-lb. rail. As a rule only one spike is used on the inside of the tie plate for both single or double shouldered construction. In a welded track of 100-lb. section rail, using two spikes on the inside, the length of the square piece of iron or steel would be equal to the distance between the two spike holes, which in this case would be 3 inches. The square steel lug is welded the full length of the lug and the only weld being between the lug and tie plate (see Fig. 14 for detail on the welded double shouldered tie plate). There is no welding between the rail and lug, nor between the rail and tie plate.

When a $^1/_2$-inch steel lug is used a $^3/_8$-inch fillet weld is used.

When single shouldered tie plates are thus made into double shouldered plates, it is impossible for the rail to buckle laterally and this square shoulder, which is held firmly up against the rail base while it is being welded, helps to prevent the rail from creeping. Perfect line and gage in track is possible with this construction.

THE CONSTRUCTION OF Locomotive Cylinders by Welding*

By G. AUGEREAU

THE Paris Orleans Railroad had constructed at Perigueux two simple welded cylinders for Mikado type locomotives, and the L. M. S. Railway at Derby, England, had manufacturered by welding two simple exterior cylinders for a Prairie type locomotive.

Encouraged by the previous progress we did not doubt for one moment our own success in a similar venture.

Pressed for time we kept strictly to cast cylinder design (in particular); the previous thicknesses were retained.

Even then, certain parts were maintained in cast steel, such as exhaust tees and admission valve parts for high and low pressure cylinders, which were impossible to develop or form as quickly as was necessary.

We insisted that these cast parts be of low carbon (<0.2 C), sulphur and phosphorus (<0.03 S and P) content. In fact we had a good quality steel, an electric arc furnace product of excellent analysis, which assured the easy welding of the work in question.

Another point is that in view of the time limit imposed we could not permit the study of other parts which might easily be of welded construction. We had to be content with one analysis of each type of cylinder to design the necessary elements and be sure of a rational construction without possibility of failure.

This for us meant that the fillet welds which constitute the majority of welded joints would have a calculated stress not over 2800 lb./in^2.

This design stress, which may appear low, is imposed by the importance of internal stresses that can be expected in our construction and by our inability to measure them.

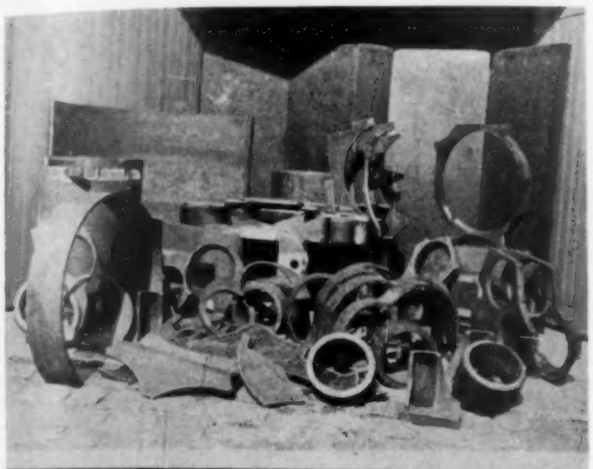
The stress relieving heat treatment that we have imposed frees a considerable part of them, but during the construction these residual stresses must not cause the slightest crack.

Examined in detail the low-pressure cylinder is composed of five structures which must assure staunchness between them; they are

First, the two main cylinders.

* Translation of La Construction par soudure des cylindres de locomotives, published in *Bulletin de la Société des Ingenieurs Soudeurs*, No. 45, March–April 1937. Translation contributed by C. J. Holslag, Electric Arc Cutting and Welding Co. Mr. Augereau is Engineer with the French State Railways.

Fig. 1—Complete Set of Parts for a High Pressure Locomotive Cylinder of Welded Steel



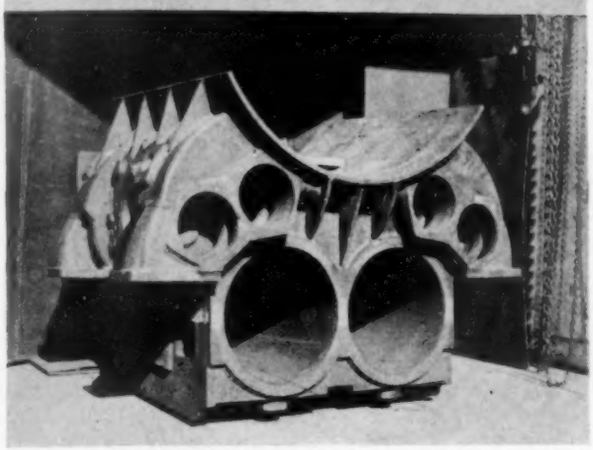


Fig. 2—Low Pressure Locomotive Cylinder

Second, the admission chamber or receiver for low-pressure cylinders.

Third, the exhaust pipe.

Fourth, between the two there is a space open sometimes for admission, sometimes for exhaust.

Fifth, the remainder is a chamber in two parts without pressure comprising the valve gear.

To those chambers must be added the main supports, lesser supports, the cylinder attachment to the bogie truck, the lateral support fixed to side frame and upper cradle clamping the boiler to the cylinders.

Each one of those parts were designed in such a way that all joints were easily accessible for welding.

At the same time another important difficulty was the necessity for alignment between machined faces, rigorously imposed by the existing parts of the locomotive.

The bottoms of valve boxes and their caps were made by oxy-cutting of a forged bloom of 250 mm. by 350 mm. section, measuring from the two bottoms 680 mm. of length and weight of about 450 kg. before cutting and forming and 115 kg. when ready for welding. The cylinders were thus partly cast steel, and some high carbon rail stock and some forged steel and rolled steel, the three last conforming with railroad specifications.

PROCEDURE CONTROL OF CYLINDER BUILDING BY WELDING

You may well realize that for a work so complicated it was impossible to leave to the welder the assembling of the work in the order of his choice, nor to allow him to select the sequence of welding. Those determinations are important to the success of work of this kind and it is given to engineers and technicians who have studied the work, to establish the designs with correlation of all necessary elements, elements numbered in sequence on the blueprints.

In fact, the assembly order and the design of details of all the elements were done by Mr. Taphanel and their verification by Mr. Evrard, engineer of the firm of Dabeg Co.

All the elements, defined by this study, were made to shape by oxy-cutting by machine following a templet except the preparation of welding scarfs, which was done by hand. In many cases, the oxygen cut surfaces were ground.

The low pressure cylinder is composed of 179 pieces of 65 different forms representing 750 feet of cutting (Fig. 1). A high-pressure cylinder has only 62 pieces of 40 different shapes with 425 ft. of cutting. The total length cut is then 1550 ft., or for the three engines that were welded, over 4600 ft.

DISTORTION

As you may well guess, overcoming distortion was a great worry.

To reduce them, predistortion often was resorted to, in order to offset the distortion by internal stresses as much as possible.

In joining two cylinders we forced them 0.32 inch out of round with a screw jack applied horizontally near the ends of each. The jacks were only removed after completion of the principal joints at the base and exhaust pipe.

Whenever it was possible to maintain the pieces strapped on a plate, we adopted this solution to reduce distortion. This was particularly the case for the frame of the low pressure cylinders.

The sub-assemblies having been completed they were assembled together. These operations were carefully controlled with the aid of surface plates as in machine shop practice. The order of final assembly was: Clamping

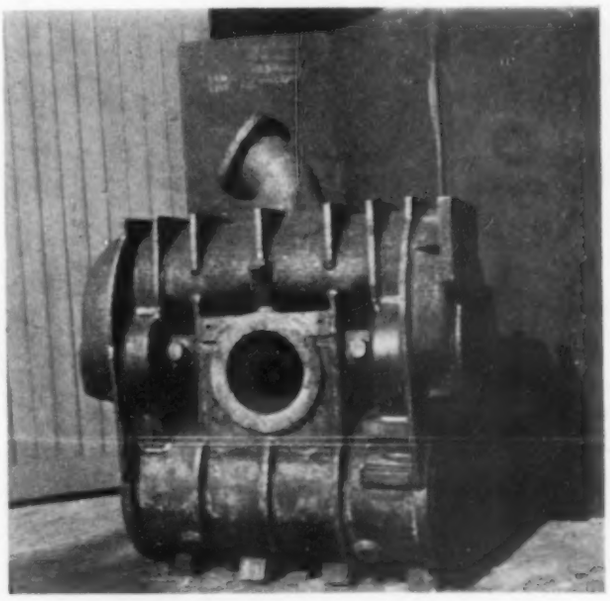


Fig. 3—High Pressure Locomotive Cylinder

of the two cylinders on the jig, then joining of the branches of attachment to locomotive frame pieces with the valve assemblies and lastly the welding of valve gear boxes. Next were attached the ends of the cylinders and the admission ports. These are braced by welded branches to offset distortion.

Clamping of lateral plates of steam chambers alternately to the inlet and exhaust branches.

Stress relieving at 650° C. was done to free the welded structure of internal stresses. The stress annealing temperature was reached in five hours, it was maintained at 650° C. for two hours, then cooled in the annealing furnace to 150° C. in 12 hours.

PROCEDURE CONTROL

If ever there was a difficult structure from the standpoint of welding, it is the locomotive cylinder with which we had to deal.

Before welding we were particular, naturally, as to the verifications of best methods and as to the qualification of welders for butt and fillet welding.

During the welding the form of elements and their inter-position did not allow of measurements being made to check dimensions. We were reduced to visual examination of lines of welding and surrounding contour appearance.

The root beads were executed with electrodes 0.16-inch diameter at 160 amperes assuring, especially in fillet welding, good root penetration. This is essential as reliability not only depends on the electrode but much more on high current.

After the welding there could be no question of destructive tests on a piece as important as a cylinder. Therefore we had at our disposal only hydraulic testing at a pressure 70 lb./in^2 higher than design pressure for each compartment of each cylinder.

We have made a comparison of cost of welded cylinders described in this paper with the cost of standard cylinders made of cast iron and of modern cylinders made of cast steel.

The cost of cylinders in cast iron, welded steel and cast steel is sensibly in the ratio of 1, 2 and 3 in the case of an order of at least 10 cylinders of each kind and to 1, 1.2 and 2.2 in the case of isolated cylinders.

Only Steel Pipe Could Take This Punishment

By A. F. DAVIS*

STEEL pipe, arc welded, can certainly "take it." This was demonstrated recently in Colorado when a 60-foot span of water-filled 84-inch arc-welded pipe was left hanging in mid-air for a considerable time and then toppled to the ground when a concrete support at one end gave way. The pipe was crumpled right across the arc-welded joint without as much as cracking the weld.

Santa Maria Reservoir, located on North Clear Creek, about 30 miles up the Rio Grande River out of Creede, Colorado, stores water in the winter and early spring for irrigation use in the San Luis Valley. A pipe line 8100 feet long diverts water out of North Clear Creek. From the outlet end of this pipe line a canal 1 3/4 miles long carries the water the rest of the way to the reservoir.

In 1934, the Thompson Manufacturing Company, Denver, Colorado, entered into a contract to replace the 8100 feet of wood stave pipe with a welded steel pipe line 84 inches in diameter. Adjacent to the diversion dam, 700 feet of this new pipe was of 1/4-inch wall supported above the ground by stiffener rings on low concrete piers about 30 feet centers. The balance of the line was of 5/16-inch and 3/8-inch wall and was buried. The maximum working pressure was approximately 175 foot head. It required over nine miles of electrically welded seam to joint the plates together in the fabrication and installation of this pipe line. The welding was done by the shielded arc process.

* Vice-President, The Lincoln Electric Company, Cleveland, Ohio.

The outlet end of the pipe was bulkheaded with a steel bulkhead and the pipe was filled with water and tested for leakage in November of 1934. The temperature of the test water was just above the freezing point. This is significant because very cold water will leak from a pipe line where water at normal temperatures will not. Notwithstanding the coldness of the test water there was absolutely no loss of water through leakage in the nine miles of welded seam during the twenty-four hour test.

During the winter, the flow in North Clear Creek is very low, amounting to only 12 or 15 cubic feet of water per second, and this, in the early part of the winter, is mostly slush ice. On November 8, 1938, the pipe line was carrying 12 or 15 cubic feet per second of this water and slush ice. Due to negligence on the ditch-rider's part, the slush ice was allowed to pile up and freeze in the concrete outlet structure of the pipe line until it formed an ice dam in the concrete outlet structure. The ice dam finally built itself so high that water could not go down the canal and was forced to overflow the concrete structure and run down the hill along the pipe line. This water

Fig. 1—Washout Looking Toward Broken Outlet Structure Pipe Wrinkled Where Man Stands

Figs. 2 & 3—Showing How Pipe of 5/16-Inch Steel Wrinkled Across Weld Neither Steel Nor Weld Broke

finally washed out a hole 24 feet deep and 50 feet wide, exposing 60 feet of the 84-inch diameter pipe. The pipe, full of water, hung in mid-air this way, supported on the ground at one end and on the concrete structure at the other end, until the concrete structure, which was undermined, gave way. The weight of the concrete, and the lack of support at that end of the pipe, of course, bent the pipe line down. However, the steel pipe did not break, but merely crumpled in at the point where it bent. The crumple is shown in the accompanying pictures. It will be noted that the pipe crumpled badly across a welded girth seam. The weld, however, did not crack, even though the temperature was close to 32°. This is an outstanding example of the perfection of modern day electric welding. The steel pipe which dropped flattened down until its vertical diameter was approximately six feet.

The chief cost of repairing the break consisted of backfilling the hole and in pouring the new concrete structure. Putting the steel pipe back into serviceable condition was a small matter. The only new material needed was an expansion joint and 7 or 8 feet of pipe. The 60 feet of pipe which had been flattened was straightened out and welded back to the undamaged end of the pipe line, cutting out the crumpled section.

A Hint on Bushings

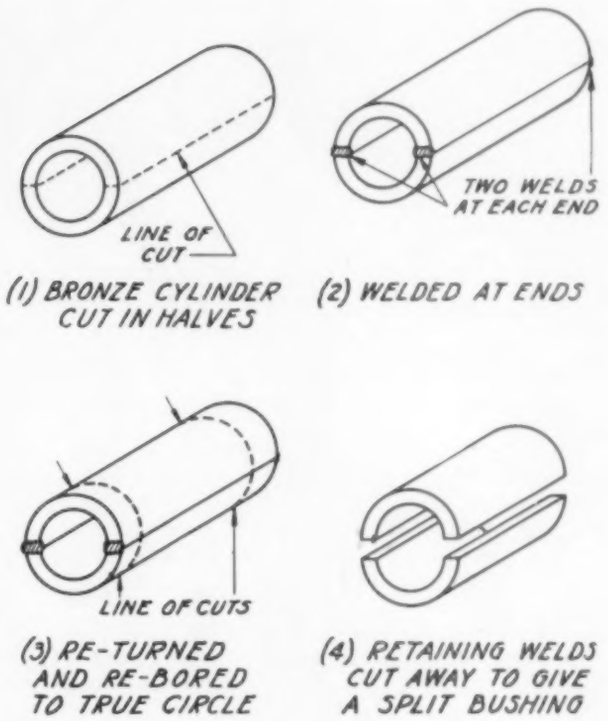
By J. S. GRAHAM, JR.*

BRONZE-WELDING AIDS IN THE FABRICATION OF LARGE SHELL BUSHINGS FROM BRONZE CYLINDERS

THROUGH the use of an ingenious bronze-welding procedure, devised by a welding operator, the process of turning out true-circle shell bushings from split bronze cylinders has been simplified so that they are now produced quickly and economically.

* The Linde Air Products Co.

As is readily realized, when a cylinder is split in halves lengthwise, planed uniform and reassembled, the halves no longer form an exactly circular cylinder, due to the loss of metal along the line of cut. Since the shell bushing must be made to form a true circle, considerable re-turning and re-boring is necessary. During these operations, the cylinder halves must be held together firmly lest the cutting tool push them out of line. This is done by bronze-welding the two semicircular halves at their ends, as shown by the accompanying sketch.


LINE OF CUT
TWO WELDS AT EACH END
(1) BRONZE CYLINDER CUT IN HALVES
(2) WELDED AT ENDS
LINE OF CUTS
(3) RE-TURNED AND RE-BORED TO TRUE CIRCLE
(4) RETAINING WELDS CUT AWAY TO GIVE A SPLIT BUSHING

These Sketches Indicate the Method Used for Making Shell Bushings from a Bronze Cylinder

STEPS IN FABRICATION

For a bushing 9 inches long, for instance, a bronze cylinder 13 inches long, 6 inches in diameter and with a wall thickness of 1 inch is used. The cylinder is first placed in a chuck and turned to rough size inside and out, inside chucking being used for turning the outside its full length. The cylinder is then sawed lengthwise and the cut edges planed down until the two parts are exactly the same size. After carefully clamping together the two halves, the operator applies a small amount of bronze rod to weld the ends together. The result is a firmly secured cylinder, but one that is no longer exactly circular in shape.

This cylinder is then re-turned and re-bored until it has the desired diameter and the correct circular shape. The next step is to cut off one of the ends close to the weld. The cylinder is reversed in the chuck, and the other end cut off. The result is a perfect split shell bushing.

It is interesting to note that the welding operator has had a large number of similar jobs come his way since he first perfected this procedure. It is often through just such small applications that the inherent advantages of welding first make themselves known to the non-user.

THE FABRICATION AND WELDING of Stainless Alloys*

By A. J. MOSES†

THE fabrication and welding of stainless alloys is attended by many hazards. Basically good material may be seriously damaged in the fabricating processes, and unfortunately this damage may not appear until after the structure has been put into service. Those alloys which appear to present very few problems in fabrication very often prove the most disappointing to the user. As a result, some alloys are considered fickle and unstable. Perhaps they are not so fickle and unreliable. Perhaps each will give consistent results, if in its manufacture, fabrication and use, the laws governing its behavior are fully complied with. Where failures attributable to the material occur, it is perhaps safe to say that at least in some one particular, some law governing the behavior or use of the metal has been violated.

Fabricators cannot generally testify directly as to the suitability of a particular alloy for a particular service. This decision usually falls to the lot of the designer or to those familiar with the service contemplated. Usually the selection of a particular alloy can be based on known satisfactory performance in the same or similar service. Frequently, however, the designer must call on the experiences of others, or must obtain test data from alloy steel manufacturers and fabricators. He must be very careful in giving consideration to unsupported recommendations of steel manufacturers and fabricators, more particularly if these are not corroborative.

After weighing the evidence and deciding on the materials, specifications must be agreed upon. Then a design must be effected which is in harmony with the specifications and with what the steel manufacturer and the fabricator can and cannot obtain. In order to be successful in this, the designer must be thoroughly familiar with the service requirements, embracing such factors as corrosion, working stresses, and the direction and distribution of same. These must be matched with satisfactory properties in the material undamaged by fabrication of the design, to a degree which will satisfy the overall economy sought. The design must take into consideration the state within which the material must be kept or finally established, in order for it to exhibit in service satisfactory corrosion resistant and physical properties. It must take into consideration the physical properties in the direction in which the material is to be subjected to important stresses. Some materials exhibit fairly uniform directional properties, while some do not. For instance, in some cases the tensile strength in one direction may be as low as 25% of the tensile strength in the optimum direction.

Restricting this discussion to the ferrous alloys, that alloy of iron containing about 18% chromium and about 8% nickel is the most commonly used. This is an austenitic steel which means that all the ingredients have solidified as a solid solution, in much the same manner as ordinary glass. It is non-magnetic in its normal state and has a coefficient of expansion about 50% greater than that of ordinary carbon steel. It demonstrates a high degree of ductility when tested in its normal state through a wide range of temperatures. It develops a considerably higher tensile strength than ordinary boiler steel, but, relatively, has a much lower proportional limit. Mechanical working causes a severe hardening of this material. Annealing requires a rapid cooling from above 1800° F. This commonly called 18–8 steel resists oxidation up to a very high temperature and, on account of its retained strength at elevated temperatures, is frequently used for such service. It also fully resists the action of a large number of corrosive agents and it is in this field that it is mostly used.

18–8 may develop two principal diseases which are exceedingly harmful in pressure vessel operation. Severe hardening under mechanical working has been mentioned. This is attended by a loss in ductility and a lowering of its corrosion resistance. Cold working of this metal changes its very nature, as evidenced by the fact that severely strained 18–8 becomes slightly magnetic. The other disease has been traced to the influence of carbon in this alloy. Carbon is definitely injurious, in that, in following certain procedures or under certain circumstances, it promotes embrittlement and a susceptibility to intergranular corrosion. This suceptibility may be induced by prolonged heating within a critical temperature range, or by a lack of rapidity in cooling through the critical range from the annealing temperature, or it may arise from service within the critical range. Such impaired material rapidly disintegrates when subjected to stressing in the presence of certain corrosive agents. Many failures arose from this cause during the early history of this metal. But, with added experience and maintenance of low carbon content, this alloy may now be expected to give entire satisfaction in a wide field of application.

Viewed superficially, the fabrication of pressure vessels of 18–8 stainless steel presents very few difficulties. It is a ductile metal, easily worked and easily welded. During fabrication, no troubles are encountered, and, if damage is done to the material, this is difficult of detection and may be left for discovery by the user, in service. If such is the case, the user may attribute failure to a so-called temperamental alloy, rather than to a failure on the part of the fabricator to conform to proper metallurgical treatment in all fabricating operations.

Viewed with understanding, fabrication is fraught with many hazards which must be avoided or nullified. Some parts may require cold forming and some parts may require hot forming. Both are injurious. The former causes hardening and sets up strains which will accelerate corrosive attack. The latter, if not properly controlled, by prolonged heating within the critical temperature range, may develop a susceptibility to

* Presented at Meeting of Philadelphia Section of AMERICAN WELDING SOCIETY, Philadelphia, Pa., November 1, 1938.

† Combustion Engineering Co., Inc., Chattanooga, Tenn.

intergranular corrosion. Localized heating operations may be necessary and may prove deleterious for the same reason. In welding, deposited metal must be obtained substantially equal to the parent metal in all its properties, without serious impairment to the adjacent parent material. The nicety of control necessary in all of these operations depends upon the severity of the service contemplated, and upon whether a final rectifying heat treatment is to be given the structure. Due thought must also be given to the expected efficiency of the heat treatment. This, in turn, will depend upon the design, the mass of the structure, and the ability and facilities for the proper handling and for the achievement of a rapid cooling from the annealing temperature.

The theoretical heat treatment for 18–8 steel is often impractical of application. It has been found that the addition of titanium and of columbium have a stabilizing effect on this metal, inhibiting intergranular corrosion and, in many cases, making unnecessary a final corrective treatment. However, the addition of such elements is not a "cure all," in that they have certain bad effects and give rise to other problems which must be considered closely. Both cause a reduction in the general corrosion resistant properties and in the ductility, as compared to fully annealed 18–8 low-carbon steel. Titanium is difficult of introduction into weld metal, and its use is declining in favor of columbium, which is readily introduced into the weld metal. However, columbium appears to promote an unbalanced alloy. In its use, the ratio of austenitic forming elements to those promoting a ferritic alloy must be carefully controlled, or else a serious reduction in ductility will be encountered. Mechanical working such as peening, or perhaps the stresses set up by contracting weld metal, may be sufficient to throw this alloy out of balance. A full anneal with a rapid cooling will correct such a condition, but the generally recommended stabilizing treatment at a lower temperature is not always efficacious.

In an attempt to cure the basic ills to which the 18–8 family is subject, development of variations in the alloy have been rather rapid. As in all such rapid developments, we are subject to what might be called growing pains. In some cases the modified alloys have been extended to services for which they are not required and before a thorough understanding was obtained of their overall behavior.

Mr. E. C. Chapman, metallurgist for my company, has made an intensive study of the 18–8 columbium alloy in connection with the fabrication of some relatively heavy wall pressure vessels of this material. The fabrication of heavy wall vessels brings to light additional information on the characteristics of alloys, more than can be obtained in the welding of thin gage material. I recently asked Mr. Chapman for his comment on this material, which has been accepted by the A. S. M. E. Boiler Code for welded pressure vessels. The Code, in Case No. 834, has accepted material of the following analysis:

Chromium	17.0 % min.
Nickel	9.5 % min.
Carbon	.07% max.
Manganese	.40 to 1.50%
Columbium or Titanium	10 × carbon with 1% max. 6 × carbon with 0.60% max.

Physical requirements are as follows:

All Weld Metal—75,000 lb./sq. in. min.
All Weld Metal—20% Elongation in 2 inches.
Transverse Tension—75,000 lb./sq. in. min.
Bend Test—20% elongation of outer fibers after subjected to copper sulphate-susceptibility test for carbide precipitation for 48 hours, after 1200° F. treatment for one hour.
No general corrosion test required.

Mr. Chapman has observed some inconsistencies in the properties of the above metal, particularly in connection with the ductility of weld metal. These inconsistencies were first noted in specimens given the so-called stabilizing heat treatment at about 1600° F., as recommended by some metallurgists. It was observed that this difficulty could be eliminated by a higher heat treatment of about 1850° F. This practice was recommended and followed for several years. With the acceptance of this material by the Boiler Code, the demand for the minimum temperature anneal seemed to increase. It, therefore, became necessary to find out what is wrong with the metal or with the prescribed heat treatment.

The evidence indicated that metal of an analysis within the ranges permitted in Case No. 834, particularly weld metal, is unstable and apt to undergo transformation changes under certain fabricating conditions; also that the 1600 degree heat treatment will not rectify this condition if it has occurred. In view of our long experience with ordinary 18–8 and its excellent ductility, it is evident that the stabilizing element, in addition to its beneficial effects, also has some harmful ones which must be nullified.

18–8 is a metastable alloy tending to change from the austenitic to the ferritic state, or it may be called a supersaturated solution tending to precipitate into an aggregate. One component of this aggregate is ferritic iron. Normalized 18–8 will contain some ferritic iron, and rapidly quenched 18–8 will probably have some slight amount. But normally the alloy is largely austenitic unless cooled to the transformation temperature which for this alloy is sub-zero. The effects of the various elements present in the alloy are as follows:

Increasing the nickel content in carbon steels, and in chromium steels, lowers the transformation temperature. When about 8% nickel is reached, the alloy is normally largely austenitic. Therefore, nickel is an austenite former. Raising the carbon also tends to produce austenite, both in carbon steels and in 18–8, but in the latter it is objectionable because of precipitation hazards. Manganese is also an austenite former.

On the other hand, chromium tends to promote a change to ferrite and when increased above 18% is acting against the formation of austenite. Columbium, the stabilizing element usually employed, is also a ferrite former, and should be kept as low as possible, after sufficient amount is added to satisfy the carbon. Mr. Chapman believes that in combining with the carbon, the columbium acts to nullify the beneficial effect of carbon in promoting austenite.

It is well known that cold working, such as peening weld metal, severely hardens ordinary 18–8. In the case of 18–8 columbium alloy, cold working not only hardens, but apparently promotes further transition to ferrite. The 1600 degree treatment does not appear to restore this low temperature ferrite to the austenitic state. Difficulties encountered with ductility in weld metal of this alloy can be reproduced by peening the weld beads. Sixteen hundred degree heat treatment will not always restore the damage done by such cold working, but an 1850 degree treatment apparently always effects a cure.

From this experience with 18–8 columbium it appears desirable to hold the chromium to 18% maximum, or from 17 to 18%, certainly not over 19%; to hold the

nickel to 10% minimum (with 17 to 18% Cr) and increasing in proportion to chrome increase; to fix the minimum nickel content at, at least, 11% with 19% chromium, and preferably 12%; to set the carbon content at 0.08% max. for weld weld, instead of 0.07% max. now required (the carbon content in weld metal can very readily be permitted to exceed that permissible in the base material); to require a columbium content of from 8 times the carbon content to a maximum of 0.90%; and to use a minimum manganese content of 1.5%.

The above recommendations are primarily for weld metal. Such requirements may not prove a "cure-all" in making permissible the minimum or stabilizing heat treatment under any and all circumstances. However, following these recommendations, we have obtained much more consistent results in the fabrication of this alloy.

The 18–8 molybdenum steel is another member of this alloy family which has been used extensively in welded pressure vessels. It is my understanding that the Boiler Code Committee now has up for consideration a new case covering this alloy. The specifications will probably call for about the same physical requirements as in Case No. 834, together with the same susceptibility test. The proposed chemical analysis is as follows:

Chromium	17% min.
Nickel	7% min.
Carbon	.07% max.
Manganese	1.40 to 2.50%
Molybdenum	2.00 to 4.00%

The specifications will probably provide for the use of titanium or columbium. Two optional heat treatments are being considered; one at 1900° F. with a rapid cool, and the other at 1600 to 1650° F. followed by cooling in still air, holding sufficiently long to provide freedom from intercrystalline corrosion.

This alloy has been used successfully in hot acetic acid service where ordinary 18–8 broke down. It does not seem to suffer from intercrystalling attack so badly as the straight 18–8 metal. However, microscopic examinations show that considerable carbide precipitation can, and frequently does, occur. These carbides cannot be dissolved below 1900° F. The addition of molybdenum up to 4% to 18–8 or to the 25–10 alloys has little or no effect on the welding of these steels.

High chromium irons are another group of stainless alloys frequently used in the construction of tanks and pressure vessels. Only steels above 11% Cr are classed as stainless, this being the lower limit at which they resist, indefinitely, atmospheric corrosion at room temperature. In general, the corrosion resistance increases rapidly with the chromium content up to 18% and less rapidly above that point up to about 30%.

The stainless chromium alloys which are satisfactorily weldable for pressure vessel service fall into two groups, one containing from 12 to 14% Cr and the other from 15 to 18% Cr. The first group are air hardening or martensitic steels. The second are borderline steels between the lower chromium martensitic steels and the higher chromium ferritic irons which cannot be hardened by quenching. A narrow range of chromium iron containing from 15 to 16% Cr is of great importance in the fabrication of welded pressure vessels. This alloy resists nitric acid and other corrosive agents much better than the lower chromium alloys. Also it has better welding properties than the higher chromium irons and is not so air hardening as the 12 to 14% chromium group.

This 15 to 16% chromium iron, being partially martensitic and partially ferritic, is magnetic. It demonstrates a very satisfactory degree of ductility in the annealed state. It also has some higher tensile strength than ordinary boiler steel, and relatively about the same yield point. Mechanical working does not cause severe hardening of this material. Annealing requires from 4 to 5 hours soaking at about 1425° F., followed by a very slow furnace cool. This alloy resists oxidation up to about 1550° F., and the action of nitric acid in certain solutions, and many other corrosive media.

Most of the difficulties met with in the fabrication of this material are in connection with the welding. The air hardening property of this chromium range, although considerably less in intensity than in the lower range, is sufficient to make chipping or machining very difficult unless annealed or heated. Heating to 300 to 400° F. is sufficiently softening for these operations. Often interstage anneals are advisable during the process of fabrication. Equal corrosion resistance properties in weld metal and base material require a very close control of deposited metal analysis.

The hazards attending the welding of this alloy make it necessary in connection with the construction of pressure vessels that a design be effected which will permit of X-ray examination of all important weld seams. The weld metal is not subject to harmful porosity, but on account of its air hardening propensity is susceptible to cracks, if a most rigid control is not maintained over the welding procedure. Fortunately, the heat treatment required by this material is a thoroughly practical one. Heat treated vessels, with welds which are proved to be sound, are not so subject to sudden and unexpected failures in service.

The greatest difficulty in welding the chrome iron alloys up to the 15 to 16% chromium range is caused by the air hardening properties of these steels. A great deal of effort is now being made to produce non-hardening varieties of these alloys. Columbium or titanium reduce the air hardening tendency considerably. Aluminum also has the same effect to a lesser degree. Columbium and titanium, by combining with the carbon, act to nullify its air hardening effect. Aluminum, by acting to prevent the formation of martensite, also is effective as a non-hardening agent.

It is rather difficult to recover titanium in fusion weld metal, but it is being used in base materials. Columbium can be recovered in fusion weld metal up to about 80%; however, columbium by itself promotes very large grain growth with attending brittleness. A high columbium content in combination with molybdenum or tungsten is now being tried out. It is hoped that these combinations will prove more successful than did the use of columbium alone. Aluminum, also, cannot be recovered in fusion weld metal and, therefore, its beneficial effects cannot be extended to deposited metal.

The difficulty which must be overcome in order to satisfactorily weld the high chrome irons above 18% chromium is the very large grain growth of this material in the welding process. The weld metal is very brittle. Nitrogen is being used for grain refinement of these high chrome irons. In the welding of 25% chrome alloy a very definite improvement in the ductility of the weld metal has been obtained. In castings of this material, nitrogen is being introduced with titanium cyanonitride. While these developments are very interesting, the full effects of additions for reducing air hardening and for reducing grain growth have not been ascertained as yet.

Within this short space of time, it is hardly possible, nor have I attempted to cover many details connected with the fabrication and welding of the many stainless alloys in use.

Welding Society ACTIVITIES — Related Events

ANNOUNCING NOMINEES FOR OFFICE OF DISTRICT VICE-PRESIDENTS FOR YEAR 1939-1940

In accordance with By-Laws Article V, Section 6, there is published below list of candidates nominated by the various District Nominating Committees for the office of District Vice-President.

New York & New England District—Wendell F. Hess, Rensselaer Polytechnic Institute, Troy, New York.

Middle Eastern District—L. C. Bibber, Carnegie-Illinois Steel Corp., Pittsburgh, Penna.

Middle Western District—K. L. Hansen, Harnischfeger Corporation, Milwaukee, Wisconsin.

Southern District—A. J. Moses, Combustion Engineering Co., Chattanooga, Tenn.

Pacific Coast District—L. W. Delhi, Western Pipe and Steel Co., San Francisco, California.

You are reminded independent nominations may be made by petition of 25 or more members, sent to the National Secretary, not later than May 15th. Such petition for the nomination of District Vice-President must be signed only by members within the District concerned.

The national ballot for nominations of officers will include the names of the District Vice-Presidents nominated by the District Nominating Committees, and the names of nominees nominated by petition. Only District members will be eligible to vote for District Vice-President.

STREAMLINED STAMINA BELOW THE WATER LINE

The trim virility of arc-welded steel construction is pictured in the view shown on the front cover, of the business end of a towing tug recently constructed by Canadian Vickers, Ltd., Montreal. The vessel is characterized by a raking stem, flat plate keel, and hull especially stiffened for working in ice. The stern is of special construction designed for the incorporation of Kort Nozzles which are built homogeneously with the ship's hull around each propeller. This is a unique departure in Canadian shipbuilding circles and one which has aroused widespread interest, although very generally adopted in Europe. Incorporated in the nozzle structure are twin Oertz Streamline Patent Rudders, the Oertz and Kort companies having cooperated in this development in order to ensure the utmost efficiency in operation and a convenient arrangement of the rudder to permit the removal of propellers and tailshaft.

BRIDGE COMMITTEE

Since the issue of the first specification in 1936 covering the design, construction and repair of welded highway and railway bridges, such rapid and varied progress has been made in the art that the Committee deemed it necessary to issue a revision or second edition. Such second edition was issued in November 1938.

It is interesting to note in connection with the Society's work in issuing these specifications that Committee XV, Iron & Steel Structures Committee of the American Railway Engineering Association, recommended that the AMERICAN WELDING SOCIETY's specifications be used, pending further consideration of the subject by Committee XV. Further, in the 1939 issue of the American Association of State Highway Officials specifications, The AMERICAN WELDING SOCIETY's Bridge specifications will be printed as an appendix; thus, the railway and highway bridge engineers have recognized the value of the AMERICAN WELDING SOCIETY's specifications.

Since the release of the draft of the 1938 specifications the committee has been active in studying the requirements of these new specifications with the view of making necessary revisions in due course of time.

SYMPOSIUM

A Symposium on Welding is being held by the Netherlands Welding Society in Amsterdam, Holland, on May 11 and 12, 1939.

The following papers will be presented:

1. The Welding of High-Tensile Steels, by J. D. Tokkinga (State Mining Engineer).
2. Welding Non-Ferrous Metals, by Dr. H. Holler (Welding Division of I. G. Farbenindustrie).
3. The Effect of Oxygen Cutting on Welding, by P. B. Vos (Director of the Bureau of Welding Information, Rotterdam).
4. Theoretical Discussion and Tests of the Strength of Welded Structures, by Prof. N. C. Kist (Technical College of Delft).
5. Stresses and Overstresses in Welded Construction, by Dr. D. Rosenthal (University of Brussels).
6. When to Gas Weld and When to Electric Weld? by J. Schreuders (Netherlands Electrolasch Co.)

An excursion is planned to a nearby mill. The Symposium Committee is headed by H. Grevers, Stradhouderslaan 102, The Hague, Holland.

RESEARCH LABORATORIES

The National Research Council has recently issued the sixth edition of a directory of "Industrial Research Laboratories," (N.R.C. Bulletin No. 102, December 1938; 270 pages).

This Directory lists 1769 laboratories of manufacturing firms and technical consultants in the United States which carry on progressive research work of any nature, aside from routine examinations or testing. Taking into account laboratories for which no data could be obtained for this Directory, the total number of industrial research laboratories in this country is estimated as about 1800.

This Directory gives, in most cases, the following items for the laboratories listed: address of the laboratory; name of the president of the corporation; name of the research director; classification of members of the research staff; total number of the laboratory personnel; research activities; cooperative researches (if any); and laboratory publications (if any). Indexes are added for serial laboratory publications, the geographical distribution of the laboratories, laboratory personnel of some 4500 names, and laboratory activities. For sale by the National Research Council, 2101 Constitution Avenue, Washington, D.C., $2.50 in paper: $3.00 in cloth.

CORROSION STUDIES

A number of technical societies and other organizations engaged in the study of corrosion have joined in forming the American Coordinating Committee on Corrosion, which is to serve as a clearing house and coordinating agency for information on experience and work in progress in the field of corrosion and corrosion prevention. The Committee was formally organized on Friday, February 17, 1939, at a meeting held at the headquarters of the American Society for Testing Materials at Philadelphia.

The formation of this Committee will, it is expected, meet a need which both individuals and organizations have felt for such a clearing house for information on corrosion work. As its first step the Committee is compiling a list of the names and

addresses of those working in the field of corrosion in this country, together with information as to their special interests and their current programs of corrosion studies. To this end the Committee is using the facilities of the various cooperating societies, supplemented by the extensive knowledge of its members on corrosion studies in progress throughout industry. Information is being sought respecting the names of individuals and organizations engaged in corrosion studies, the nature of such studies and a record of experience and publications.

The compilation of such information will serve many useful purposes both to individual workers in the field and to the various technical and industrial organizations that plan and carry out corrosion studies of many different kinds.

It is not the purpose of the Coordinating Committee to abstract the literature on corrosion.

The next meeting of the Committee will be held in June at Atlantic City, N. J., during the A. S. T. M. annual meeting, at which the information thus far compiled will be reviewed, permanent organization effected and the work of the Committee further considered. Pending permanent organization C. L. Warwick, Secretary-Treasurer of the American Society for Testing Materials, is serving as temporary chairman of the Committee.

ANNUAL MEETING

The Program of the Annual Meeting now taking shape promises to be the best in the history of the Society exceeding even last year's meeting. This meeting will be held in Chicago in connection with the National Metals Exposition during the week of October 22nd. Stevens Hotel has been selected as the headquarters of the AMERICAN WELDING SOCIETY and all of the technical meetings will be held at the hotel. The Exposition will take place at the International Amphitheatre.

Reservations should be made as early as possible and members of the Society will shortly receive a communication from the Hotel.

MOREHEAD MEDAL IS AWARDED TO JOHN J. CROWE

During the opening session of the 39th annual convention of the International Acetylene Association, John J. Crowe received the 1937 James Turner Morehead Medal for his unceasing and successful technical activities in the utilization of acetylene.

The Morehead Medal is awarded annually by the International Acetylene Association to the person or persons who in the judgment of its officers and board of directors have done most to advance the industry or the art of producing or utilizing calcium carbide or its derivatives, the most important of which is acetylene.

This award is named after James Turner Morehead who was responsible for the experiments which led, in 1892, to the discovery of the electric furnace method of producing calcium carbide. Established by John Motley Morehead in 1922, in honor of his father's work, the medal has since been awarded each year to distinguished leaders in the acetylene industry.

Mr. Crowe has been engaged in research and development work ever since he graduated from high school in Washington, D. C., where he was born and reared. He is a graduate of George Washington Univ. He is well known for his studies of metallurgical phenomena, his effective cooperation in the establishment of several leading metallurgical laboratories and his singular work, as manager of the Apparatus Research and Development Department of Air Reduction Sales Co., in the development of apparatus for oxyacetylene welding and cutting.

John J. Crowe

He is past president of the AMERICAN WELDING SOCIETY and the Compressed Gas Manufacturers' Association, a past chairman of both the Philadelphia and New York sections of the American Society for Metals.

Starting his engineering career as an apprentice at the national bureau of standards in Washington, his first assignment consisted in testing thermometers and the making of heat measurements.

Wrote Authoritative Papers

While associated with the bureau of standards, Mr. Crowe cooperated in the publication of a number of authoritative

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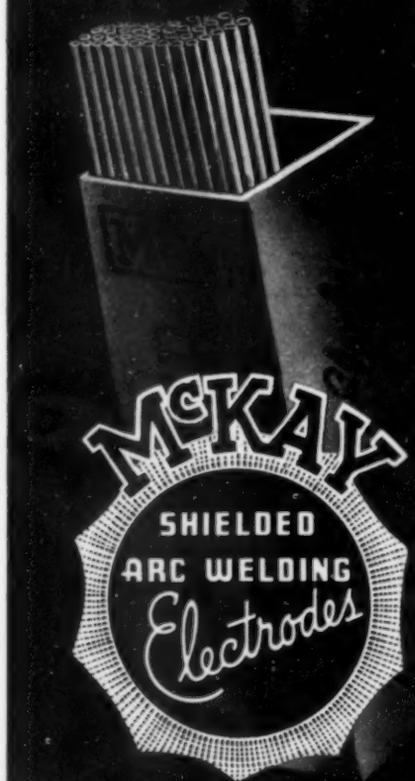

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papers on thermometry, pyrometry and metallurgy. By 1915, Mr. Crowe had been advanced to associate physicist in charge of a section in the bureau. He was "loaned" to the United States navy department to assist in the development of anchor chain at the Boston navy yard. This work soon lead to the supervision of the heat treatment of all forgings and castings, and to the establishment of a physical testing and metallurgical laboratory at this yard. Later, Mr. Crowe assisted in the establishment of similar laboratories at New York, Norfolk and Philadelphia navy yards.

Instead of returning to the bureau of standards, Mr. Crowe accepted an appointment as physical metallurgist with the navy department.

During this period Mr. Crowe had his first real contact with practical applications of fusion welding and cutting by the oxyacetylene process. By use of various applications of oxyacetylene welding and cutting he was successful in effecting great savings in the cost of producing large forgings and castings.

While at the navy yard he took an active interest in what is now the American Society for Metals, and started a course in metallurgy at Temple University in Philadelphia. During this period Mr. Crowe also acted as consulting engineer in many important developments.

Since becoming engineer in charge of the apparatus research and development laboratories of the Air Reduction Sales Company in 1924, Mr. Crowe has contributed considerably to the great progress of the acetylene industry in manufacturing, maintenance, construction, refining railroad shops and many other fields. In addition, he has written a number of noteworthy papers, including "Economies Through the Use of High Purity Oxygen," published in the JOURNAL of the AMERICAN WELDING SOCIETY in 1935, and "Effect of Tip Sizes and Pressures Upon Economy of Cutting," published in proceedings of the International Acetylene Association for 1928. He is also the author of the chapter on "Oxygen Cutting" in the handbook recently published by the AMERICAN WELDING SOCIETY.

F. M. FARMER NOMINATED BY A. I. E. E.

Frank Malcolm Farmer (A'02, M'12, F'13) vice-president and chief engineer of Electrical Testing Laboratories, New York, N. Y., has been nominated for the presidency of the A. I. E. E. for the 1939–40 term. Mr. Farmer has been particularly active at various periods in several standardization organizations. He is a contributor to several reference books, and author of a book on electrical measurements and of many papers given before engineering and technical societies. He is at present a member of the board of United Engineering Trustees, Inc., and chairman of The Engineering Foundation, on all of which bodies he represents the A. I. E. E. In addition to his Institute activities, Mr. Farmer is a director of the American Standards Association; a past-president of the American Society for Testing Materials; a past-president of the AMERICAN WELDING SOCIETY; a fellow of the American Association for

F. M. Farmer

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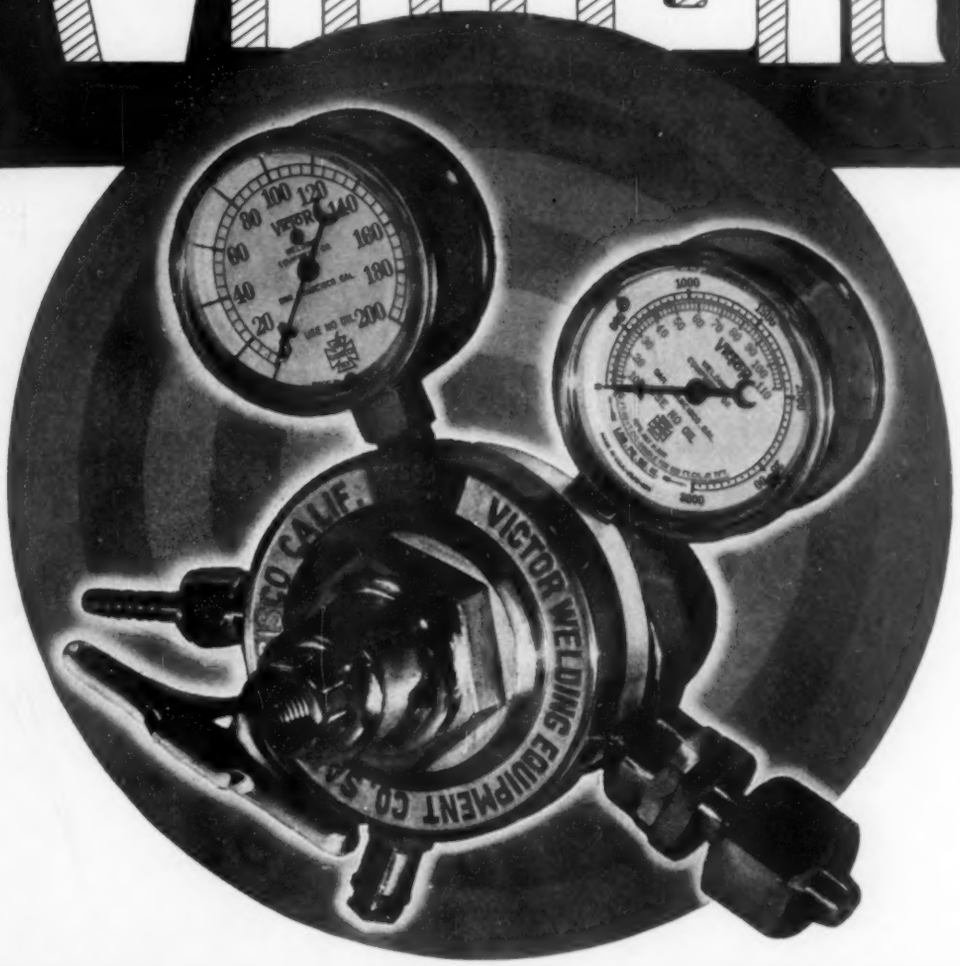

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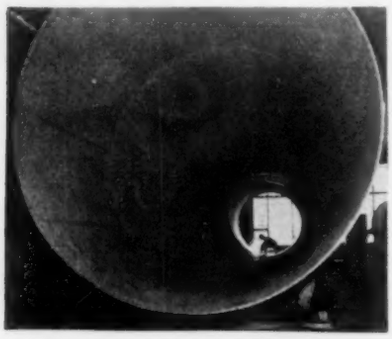
FLASH CHAMBER DWARFS WELDER

The arc welder is dwarfed inside the tunnel-like shell of a flash chamber for oil refining being built in the A. O. Smith Corporation's Milwaukee plant for foreign



shipment. It is Smithlined throughout with spot-welded chromium alloy steel sheets with the patented Smith construction. The shell is 80 ft. long and 9 ft. in diameter.

WELDING CONFERENCE AND SHORT COURSE

University of Oklahoma

March 9th and 10th 1939

THURSDAY, MARCH 9TH

"Welding of Stainless Steels," H. V. Thaden, Engineer, Carnegie-Illinois Steel Corporation.

"Welding Nickel Alloys," W. F. Burchfield, Head of Technical Service on Fabrication, The International Nickel Company.

"Structural Steel Welding," R. W. Van Kirk, Welding Engineer, General Electric Company.

"Economics of Welded Oil Well Casing," Glenn Stearns, Assistant Professor of Petroleum Engineering, College of Engineering, University of Oklahoma.

"Fundamentals of Pipe Joint Design," H. H. Bassett, District Manager, The Linde Air Products Company.

Inspection of Demonstrations and Exhibits Armory Building, University of Oklahoma.

FRIDAY, MARCH 10TH

"The Practical Significance of Technical Control in Welding," G. C. Riegel, Chief Metallurgist, Caterpillar Tractor Company.

"The Significance of Some Mechanical Tests of Welds," R. V. James, Professor of Mechanics, Head of the Department of General Engineering, College of Engineering, University of Oklahoma.

"Radiography as a Production Tool," Orville T. Barnett, Metallurgist, Black, Sivalls, and Bryson, Inc., also President of the Oklahoma City Section of the AMERICAN WELDING SOCIETY.

"Non-destructive Inspection by Magnaflux," F. B. Doane, Vice-President, Magnaflux Corporation.

"Hard Surfacing Applications," W. S. Tromley, District Manager, Haynes Stellite Company.

"Low Temperature Brazing," Wm. Whaley, Assistant Sales Manager, Air Reduction Sales Company.

"Welding Characteristics and Technique for A. C. Welders," J. L. Lang, Welding Engineer Marquett Manufacturing Company.

WELDING WROUGHT IRON

The rapid increase in the utilization of wrought iron products for various applications where fabrication is accomplished by welding and the fact that wrought iron differs both physically and chemically from other ferrous metals suitable for welding, have made it desirable to establish recommended procedures to follow when welding wrought iron by the commonly used processes. Wrought iron is easy to weld, but in order to obtain the best results the welding engineer should be thoroughly familiar with the material and its characteristics which influence weldability.

The A. M. Byers Company, Pittsburgh, Pa., has just issued an attractive pamphlet of sixteen pages copiously illustrated giving detailed information on exact procedure to weld wrought iron by the various processes. Physical properties are also indicated. Copy will be sent upon request.

THE DAY YOU WILL REMEMBER!

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—Auspices New York Section—

New York World's Fair

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I. A. A. OFFICERS

H. P. Dolisie, of Montreal, Canada, and Henry Booth, of New York were elected president and vice-president, respectively, of International Acetylene Association for 1939. H. F. Reinhard, also of New York, was re-elected secretary. The election was held during the Association's 39th Convention held at Houston, Texas.

H. P. Dolisie

Born and educated in France, and decorated with the French War Cross for bravery during the World War, Mr. Dolisie was a well-known figure in steel manufacturing circles in his native land when in 1929 he joined Société L'Air Liquide of Paris, manufacturers of welding equipment and supplies. A year later he came to Canada as assistant manager of Canadian Liquid Air Company, Limited, and in 1934 he took up his present position as managing director of that company.

Mr. Booth, who is sales manager for Shawinigan Products Corporation, New York City, will continue as treasurer of the Association, as well as vice-president. Mr. Reinhard, who begins his eighth year as secretary, is associated with Union Carbide Company, New York City.

Henry Booth

DE FOREST HONORED

Designating his "Magnaflux" method of testing "a notable contribution to aeronautical engineering," the Institute of the Aeronautical Sciences conferred its Sylvanus Albert Reed award for 1938 on Prof. ALFRED V. DE FOREST of Massachusetts Institute of Technology on Jan. 27th.

An authority on physical testing, Professor de Forest is perhaps best known for his non-destructive magnetic method of discovering flaws in metal, which is applicable to detection of forging defects, fatigue and grinding cracks, and non-metallic inclusions.

H. M. BOYLSTON RETIRES

Prof. Herbert M. Boylston, who has been on leave of absence from the metallurgical department of Case School of Applied Science, has now voluntarily retired.

Professor Boylston still carries on his consulting metallurgical practice from his home laboratory at 22275 Calverton Rd., Cleveland. He also conducts, as in the past, the well-known correspondence course on "Metallography" founded by Sauveur and Boylston more than 30 years ago and which has graduated over 1000 students.

N.B.C.'S NEW RADIO CITY

Well launched on a year which promises unprecedented radio treats and thrills, N.B.C.'s new "Radio City" in Hollywood incorporates striking evidence of advances in construction technique on many different fronts.

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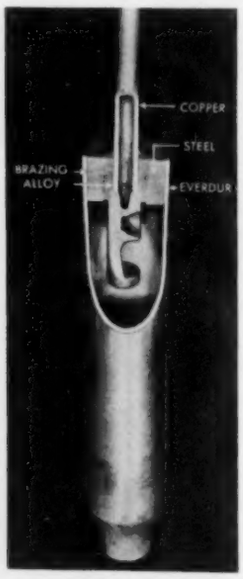
each on its own foundation and completely isolated from all other parts of the $2,000,000 broadcasting layout. Really eight separate structures wrapped in one, this Radio City of the West vies with New York's World's Fair in charting the future course of building design.

Harmonizing colors were tried and tested by The Austin Company, engineers and builders of the broadcasting "plant," on an unusual, streamlined fence which enclosed the site. They provided observation balconies in the fence which simulated the actual contours of the building, which was built the "silent way," with welders and electric motors in place of riveters and chugging gas engines.

JOINING EVERDUR TO STEEL TO COPPER

Among the features which are bringing about a lot of interest in low temperature silver brazing is the ability of certain alloys of this type to make reliable joints between dissimilar metals.

The attached illustration is a good example of this point. It shows a cutaway section of an electric refrigerator part made up from Everdur, steel and copper.



The outer shell of Everdur is brazed to a steel center section which at the same time is joined to a copper tube.

The alloy used is a low temperature composition having a medium silver content, known as Easy-Flo, made by Handy & Harman, New York. The work is done at the low temperature of 1175° F., using a flux that's fully active at 1100° F. The high strength of the bond and also its ductility make the completed assembly as sound and gas-tight in service as a solid piece of metal.

NEW R. P. I. ENGINEERING HEAD

E. H. Praeger, of New York City, has been named head of the civil engineering department of Rensselaer Polytechnic Institute, Troy, N. Y., to succeed Prof. Thomas R. Lawson, who will retire at the end of the year after forty years as a member of the Institute's faculty. Professor Lawson has directed the department since 1921. Mr. Praeger was graduated at Rensselaer in 1915.

Mr. Praeger for the last several years has been chief engineer for Madigan-Hyland, consulting engineers for Park Commissioner Robert Moses, of New York, in the group of major parkway projects for the West Side Improvement, Henry Hudson Parkway Authority, Marine Parkway Authority, New York City Parkway Authority, Bronx Whitestone Parkway, Circumferential Parkway and New York World's Fair Site Improvement. He was consulting engineer in the development of Jones Beach and other State parks on Long Island and in the construction of several buildings on the World's Fair grounds; and served as engineer for the architects in the construction of twelve buildings for the California Institute of Technology; six buildings for St. Lawrence University; the Brooklyn Law School; Dillingham Hall, Honolulu; Oriental Building and the Chapel, University of Chicago; Manhattan School of Music; Nebraska State Capitol; Los Angeles Public Library; Church of the Heavenly Rest, New York; National Academy of Sciences, Washington, D. C.; and others.

In announcing Mr. Praeger's appointment, President Hotchkiss, of Rensselaer, said: "We wanted an engineer with the vision and courage required for big undertakings and the experience that comes from achieving such undertakings. During recent years unquestionably the greatest engineering projects in the world have been those under way in and about New York City, and Mr. Praeger has been in the thick of them as a key executive."

Since the first degrees in civil engineering in this country were awarded at Rensselaer Polytechnic Institute in 1835, Mr. Praeger will direct the country's oldest civil engineering course.

A separate department is being established at the Institute for greater emphasis on the studies of forces and motion, and the testing of materials of which structures and machinery are made. It will be directed by Le Roy W. Clark, professor of mechanics at the Institute since 1921.

To increase its training and inquiry in these phases of engineering, under way many years, the Institute in addition to establishing a separate department will expand its materials testing laboratory.

Professor Clark was graduated at Rensselaer as a civil engineer in 1906. For the last twenty years he has been in charge of the Institute's buildings in addition to his teaching.

STACK-CUTTING

How large quantities of simple or intricate shapes are produced from piled sheets or plates of steel by the oxyacetylene cutting process is described in a recently published 8-page booklet entitled, "Stack-Cutting Speeds the Production of Identical Parts." Copies can be obtained without obligation from The Linde Air Products Company, 30 East 42nd Street, New York, N. Y., or from any of its District Offices.

The value of stack-cutting lies in the fact that several plates or sheets properly clamped together can be cut like one solid piece of steel. The result is greatly increased production, greater uniformity of shape-cut parts, and lower unit cost of production. This booklet describes the stack-cutting process in detail, including methods of cleaning, clamping, cutting and separating the plates. Typical stack-cutting jobs are also described and illustrated.

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NOTE WASTE OF "SIMIL AR FLUXES" ADHERING TO HOT ROD, AS SHOWN IN FIG. 2.

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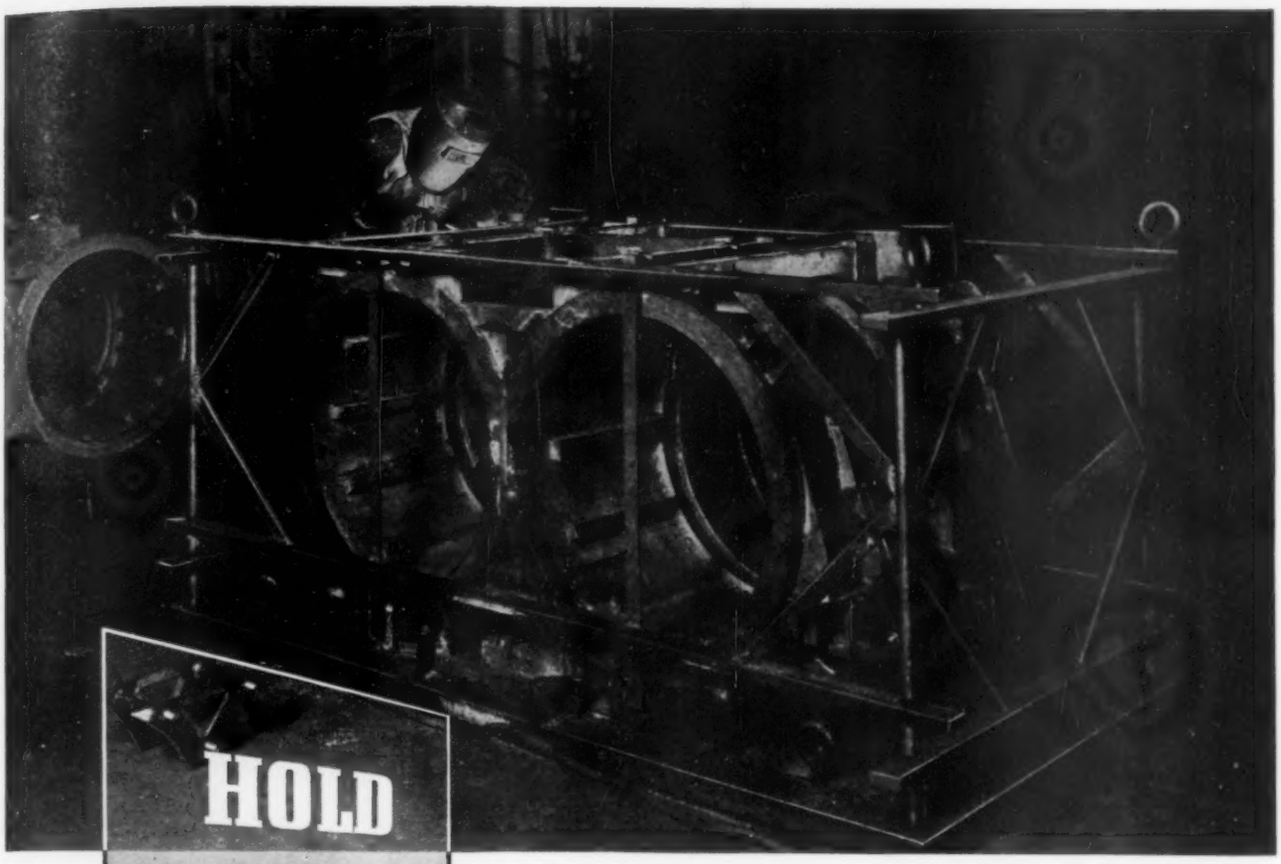

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300 BRITISH BOMBERS COSTING $25,0000,000, BUILDING AT LOCKHEED AIRCRAFT PLANT*

The Lockheed Aircraft Corp., Los Angeles, California, has under construction 300 reconnaisance bombers for the British government. The order totals $25,000,000.

Figure 1 shows a number of arc-welded jigs in which the fuselages are assembled.

Figure 2 shows the type of plane used by Howard Hughes in his round-the-world flight. It is a Lockheed Model 14 transport, which has a cruising speed of 230 miles per hour.

In addition to fabricating the jigs used in production of planes, arc welding is used

Fig. 1

Fig. 2

to construct landing gears, motor mounts, etc. This process, which is being adopted rapidly throughout industry because of its cost saving and structural advantages, was adopted by Lockheed officials following exhaustive tests which proved that this newest method of joining metals provides greater structural strength and at the same time, greatly simplifies production. For example, the company found that the average fabrication time of an airplane landing gear fork by the former method was 16 hours; by arc welding, it was 8 hours, representing a factory saving of $20 per fork. Two landing gear forks per plane means $40 saving for each plane produced, compared with the former method.

Comparing, by actual tests, structural strength obtained by arc welding and by the former method, C. R. deLaubenfels, research engineer of the company, reports arc welding provides joints 23% stronger than the former method. Actual specimens of welded tubes tested (tubes are used in fabricating the landing gear forks), showed tensile strength of arc-welded tubes 98,160 lb. per sq. in. and of tubes previously fabricated 79,390 lb. per sq. in.

The Lockheed company, one of the largest in the aircraft manufacturing industry, employs 3800 people.

* From News Release, Lincoln Electric Co.

"GENERAL PERSHING" TO BE BURLINGTON'S NINTH ZEPHYR

Chicago, Feb. 27—The Burlington Railroad announced today that its Ninth Zephyr, to be placed in operation between St. Louis and Kansas City early in April, will be named the "General Pershing" in honor of the Commander of the A. E. F. The new train now is being built by Edward G. Budd Manufacturing Company in Philadelphia.

Extensive experimental tests have proved the new type brake highly efficient. It is estimated that from a speed of 100 miles per hour, a stop can be made in approximately 2000 feet without discomfort to passengers.

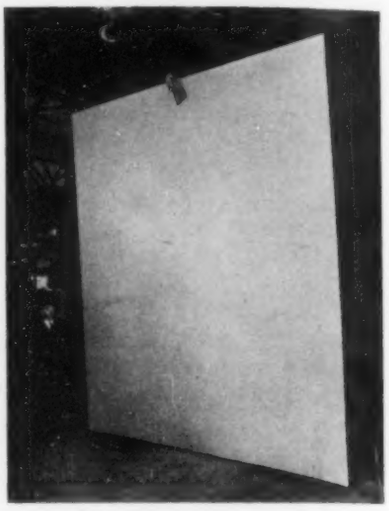
The new train will be 333 feet long, with the forward car (the "Silver Charger") containing the 1000 hp. diesel plant and compartments for baggage and express. The second car (the "Silver Leaf") will contain 70 de-luxe seats for passengers. The third car (the "Silver Eagle") will contain a large lounge for men, 52 de-luxe seats for passengers and a large lounge for women.

OHIO STATE ENGINEERING CONFERENCE

The Eighth Annual Welding Engineering Conference will be held May 11 and 12, 1939, in the Industrial Engineering Building, Ohio State University Campus. Inquiries concerning this Conference should be sent to J. R. Stitt, Chairman, Welding Engineering Conference Committee, Columbus.

WIDEST PLATES OF CLAD STEEL EVER ROLLED

The widest plates of clad steel ever rolled were recently produced by Lukens Steel Company, Coatesville, Pa., on its 206-inch plate rolling mill. Two plates were produced, each measuring 152 inches long, 151 inches wide, 3/4 inch thick and weighing 5315 lb. The nickel-cladding on one surface of each plate consisted of



Widest Plate of Clad Steel Ever Rolled

10% of the total plate thickness, or 0.075 inch.

The two plates were used by a large chemical company in forming the shell of a vessel, the 151-inch dimension being employed as the length of the shell. Availability of such wide plates permitted construction of the shell from two plates instead of three or more plates. Thus, only two longitudinal joints were necessary in the shell, and no circumferential joints excepting the usual joint at each end of the shell joining the heads to the shell.

The finished vessel, which is being built in the chemical company's own shops, will be 8 feet 0 inch outside diameter and 15 feet 11 inches high.

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SAVE MONEY... BY WELDING

Jaw Plates, Gyratory and Roll Crushers, Shovel Teeth, Hammers, Tractor Tread Grousers

with

MANGANAL

Reg. U. S. Pat. Office. U. S. Patents 1,876,738—1,947,167—2,021,945

11 to 13½% Nickel Manganese Steel

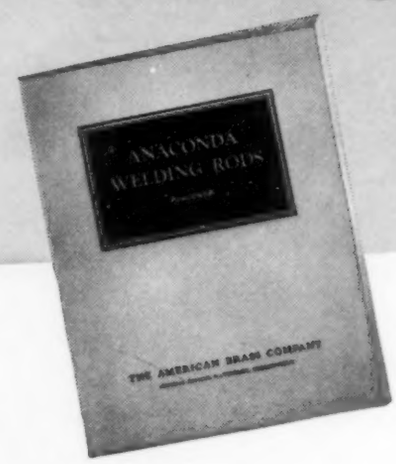
WELDING ELECTRODES, WEDGE and APPLICATOR BARS, HOT ROLLED PLATES

STULZ-SICKLES CO. *Sole Producers* 134-142 Lafayette St., Newark, N. J.

Sold Thru Distributors Only

"Don't scrap it—restore it by Tobin Bronze Welding"

This cast-iron valve casing cracked all around and would have been scrapped had it not been restored to service by means of Tobin Bronze welding.



Write for this booklet—For detailed description of Tobin Bronze, write for free copy of Publication B-13. This booklet describes the entire series of Anaconda Welding Rods . . . their tensile strengths, weights, melting points, composition, etc. It also tells which rod is best suited to different types of welding.

MELTING POINTS OF ANACONDA WELDING RODS

Material	Approx. Melting Point—Degrees		Material	Approx. Melting Point—Degrees	
	Cent.	Fahr.		Cent.	Fahr.
Tobin Bronze* . .	885	1625	Phosphor Bronze E	1070	1958
Anaconda 520 . .	885	1625	Phosphur Bronze D	1000	1832
Manganese Bronze	870	1598	Phosphor Bronze C	1025	1877
Anaconda 997 (low fuming)	870	1598	Silicon Copper . .	1083	1981
Brazing Metal . .	930	1706	Deoxidized Copper	1083	1981
Economy Bronze* .	885	1625	Electrolytic Copper	1083	1981
Everdur*	1019	1866	Super Nickel . .	1225	2237
Phosphor Bronze A	1050	1922	Nickel Silver . .	1055	1931

*Trade-marks Reg. U. S. Pat. Off.

In the repair of broken castings, this Anaconda Welding Rod saves countless dollars for industry

Welders the country over are doing "impossible" jobs with the aid of Tobin Bronze. This low melting point Anaconda Rod enables welds to be made in one-third to one-half the time required when extensive pre-heating is necessary. Particularly on cracked and broken cast-iron parts, time and money can be saved, shutdowns avoided, production and payrolls maintained.

Tobin Bronze—time-tried Anaconda product—makes dependable welds quickly, at low cost. Railroads, for instance, find it invaluable in maintenance work. Tobin Bronze carries the trade-mark "Tobin Bronze Reg. U. S. Pat. Off." on each rod. Look for this trade-mark, make certain you are getting *genuine* Tobin Bronze!

50129

ANACONDA

Anaconda Welding Rods

THE AMERICAN BRASS COMPANY, General Offices: Waterbury, Connecticut

In Canada: Anaconda American Brass Ltd., New Toronto, Ont. • *Subsidiary of Anaconda Copper Mining Company*

NEW PRODUCTS

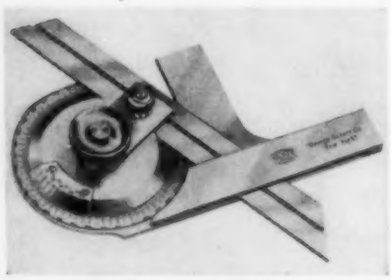
The Society assumes no responsibility for the validity of claims in this Section

ELECTRODE HOLDER AND GROUND CLAMP

The Tweco Products Company, Wichita, Kansas, has just been granted U. S. Patent No. 2,145,699 covering the Tweco Electrode Holder and Perfection Ground Clamp.

UNIVERSAL BEVEL PROTRACTOR

The George Scherr Company announces a New Universal Bevel Protractor of Mauser manufacture, producers of the well-known Mauser Vernier Calipers and Height Gages. This precision tool has been designed to meet the requirements of toolmakers, engineers, layout men and mechanics. It may be used for all types of work where angles must be laid out or measured. The dial is graduated in degrees for the full circle in 4 x 90 = 360 degrees. A vernier is provided which gives readings within 5 minutes of the arc ($^1/_{12}$th of a degree).



The graduations on both the main dial and on the vernier are very finely etched with jet black markings, making readings quick and simple. The tool may be obtained with either 6, 8 or 12" blades, which are bevelled at each end to 45° and 60°, respectively. The back of the tool is finished flat so that it may be flush when laid on work or paper. The dial may be clamped rigidly by a thumb nut, while the blade may be clamped independently of the dial.

ARC WELDER FOR LIGHT GAGE SHEET WELDING

Wilson Welder and Metals Co., Inc., New York City, announce a new arc welder of 100 ampere rating at 30 volts for light sheet metal welding and other light work requiring low current and fine control. The new machine is of the alternating current, transformer type, and designed especially for use with heavily coated electrodes. Standard wiring is for single phase, 220 volt, 60 cycle power

supply, but it can be furnished for 440 volt supply if desired. Open circuit voltage is 65 volts.

A calibrated scale on the front of this welder indicates the adjustment throughout the range of the machine, which is from 25 to 150 amperes. This adjustment is made continuously by rotating a crank at the top, and because the circuit is not broken there is no need to stop operations and open any connections while a change is being made.

Enclosed in a sheet metal housing $16^1/_2$ inches in diameter and 24 inches high, weighing 145 pounds, the new welder is a compact and mobile unit.

METAL PIGMENT

For touching up of new galvanizing, protection of welds, etc.

For projection welding. Welds are made right through the flake film; and thereby protection is provided for places hitherto very difficult or impossible to paint, as between welded plates, etc.

Bright Zinc Flake is manufactured exclusively by Tainton Products, Ltd., 3100 Elm Avenue, Baltimore, Maryland.

A-C TYPE CRUCIBLE WELD ELECTRODE

A-c crucible weld electrodes for every requirement are described in a new booklet by the Westinghouse Electric & Manufacturing Company.

Included are electrodes: in three grades for low or medium carbon steel welding, brown, black and sheet-weld; in two grades for cast-iron welding, casting weld and free machine weld; in two grades for stainless steel; in five grades for hard surfacing; and for manganese steel.

Copies of this booklet, 26–650, may be obtained from headquarters of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania.

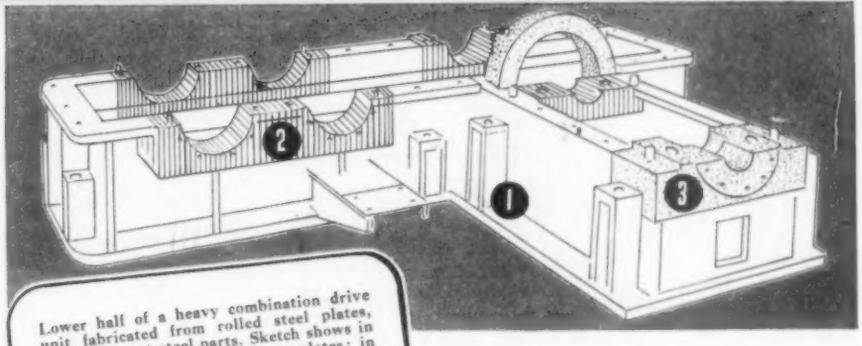
INTERRUPTING WELDING ARCS WITHOUT NOISE OR MOTION

The noisy, troublesome arcs that terminate each spot weld have been completely silenced. To use a slang but apt expression, they have been canned. The spot-welding currents are interrupted without noise, without moving contacts, in two small metal cans or tubes about the size and shape of giant firecrackers. These tubes operate on the principle of the ignitron, which has been so amazingly versatile. It is the same principle on which the ignitron timer is based; in this instance, the tubes serve no timing function, only that of a switch or contactor. The tubes accomplish their task of arc interruption by the simple expedient of stopping the current flow at the end of each half cycle and not permitting it to start on the next unless the tube gets its signal through the ignitor. The ignitor can be controlled in any usual manner as by a foot switch or electronic timer. The current is not interrupted; it just stops flowing. Two tubes are used, one for positive waves and one for negative waves. They can be considered as a full-wave rectifier, except that they are connected to give an alternating output instead of a unidirectional flow of current. The two tubes, their water connections, fuse, terminals, and so forth, are all contained in a small cabinet only slightly larger than a safety-switch cabinet. Maintenance is practically nil. (Reprinted from the *Electric Journal*, January 1939.)

150 AMP. DIRECT CURRENT WELDER

A new direct current arc welding motor generator set, with a rating of 150 amperes at 25 volts, and having a range of adjustments from 20 to 200 amperes at 25 volts, has just been announced by Wilson Welder and Metals Co., Inc., New York City.

TO MAKE YOUR ROLLED STEEL CONSTRUCTION *More Efficient...* we offer these More Efficient Steels



Lower half of a heavy combination drive unit fabricated from rolled steel plates, slabs, and cast steel parts. Sketch shows in white (1), parts fabricated from plates; in hatched areas (2), parts flame-cut from slabs; in dotted areas (3), cast steel parts. Rolled steel construction makes it possible to combine effectively the right steels for maximum functional efficiency.

U·S·S HIGH TENSILE STEELS

To carry high unit stresses and to reduce weight to a minimum at low cost. (U·S·S Cor-Ten has resistance to atmospheric corrosion 4 to 6 times greater than plain steel.)

U·S·S ABRASION RESISTING STEELS

To reduce abrasive wear wherever earth, sand, gravel, waste, etc., flow over, through or against your equipment. Costs little more than plain carbon steel.

U·S·S CARILLOY ALLOY STEELS

To strengthen vital parts—to carry tremendous bearing pressures safely. Steels to resist creep at elevated temperatures and pressures.

U·S·S STAINLESS STEELS

To resist corrosive environments. To assure long life. Special analyses can be welded with no loss in corrosion resistance.

U·S·S HEAT RESISTING STEELS

To endure high temperatures that spell disaster to other metals.

THE advantages of rolled steel construction are many. Light weight, lower cost, improved appearance, freedom of design—these are the reasons why designers are now turning to this method of building equipment.

You can sum up all these advantages with this single statement: *Rolled steel construction permits the ultimate in functional efficiency.*

To make the most out of rolled steel construction, we offer you the widest available range of metallurgy's finest steels, plus the services of experts trained in the job of selecting the right steel for a given application. You can rely on our specialists' recommendations, because they have a complete range of steels from which to choose. They are not interested in promoting any one grade or alloy over any other. Their sole interest is in helping you get the steel that will do the best job at lowest cost. Ask one of these engineers to call.

CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

Current control on this new welder consists of a three point current switch and a dial rheostat control for fine adjustment. It is stated that the smoothness and precision of this adjustment makes it possible always to get the right current, and greatly enhances the adaptability of the machine to all types of electrodes, from bare to heavily coated. Open circuit voltage is from 40 to 75 volts. The set will use electrodes up to $^{5}/_{16}$ inch diameter. Standard wiring is for 3 phase, 220 or 440 volt, 60 cycle power supply.

NEW "STURDYBENDER"

The Steelweld Machinery Sales Division of Cyril Bath & Company, Cleveland, Ohio announces a new line of smaller Bending Presses, which will be called the STURDYBENDER line. These machines have been developed to meet the demand for a sturdy, production type Bending Press capable of delivering sharp, accurate bends, and precision in multiple operation work.

The Steelweld machines now cover the field from 10 feet × $^{3}/_{16}$ inch to the largest commercial machine. Sizes of the new line of presses will be for handling from 10 feet by 10 gage material on down.

A-C WELDING CONTACTOR

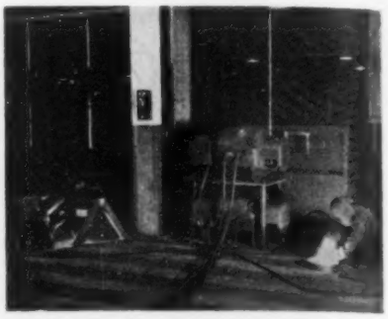
The Weld-O-Trol, a Westinghouse ignitron a-c welding contactor without timing, is described in a new leaflet being released by the Westinghouse Electric & Manufacturing Company.

For several years ignitron welding timers have been entering new fields of resistance welding. The Weld-O-Trol has been developed to meet the definite need for a non-mechanical device to open and close the circuit to the primary of the welding transformer. Cost has been kept to a minimum by elimination of the timing control panel previously furnished with all ignitron controls for resistance welding.

The pamphlet, descriptive data 18-345, which contains rating curve and complete diagrams of the unit, may be obtained from headquarters of the Westinghouse Electric & Manufacturing Company.

STAND FOR SINGLE-OPERATED WELDERS SAVES SPACE

The convenience of single-operator welding sets is often restricted because of limited floor space. Mounting of one set above the other reduces by half their required floor space and aids in maintaining an orderly welding section, for the stand of welding machines may be placed adjacent to a wall or between two columns,



eliminating an indiscriminate arrangement of single machines about the welding floor.

The stand upon which the welding machines are mounted is easily fabricated from steel plates one inch thick, some three-inch pipe, and through-bolts with nuts at a nominal cost. Stands may be made three-high but a two-high stand is more convenient to the operator.

SAFETY-SERVICE Protective Apparel for Every Welding Need

"SAFETY-SERVICE" is our Trade Mark for High Quality merchandise. For over twenty-five years, we have specialized in the manufacture of protective apparel for Welders and other trades and produce a large variety for all purposes. All garments are made of clean fresh stock and the workmanship is of the finest.

Our general Catalog No. 10-J illustrates and describes our complete line to care for every Welding need, such as leather Gloves and Mittens; Sleevelets, Aprons, Leggings and Spats made of leather, asbestos or fire-resisting Duck; one and two-piece suits made of leather, asbestos, fire-resisting Cassimere cloth, Duck or Wool, and many other items of safety equipment too numerous to mention here. Whatever your needs may be—we have it. Write today for copy of this big Catalog.

JOBBERS—*if interested in distributing our line, write us for full details of our proposition.*

SAFETY EQUIPMENT SERVICE CO.

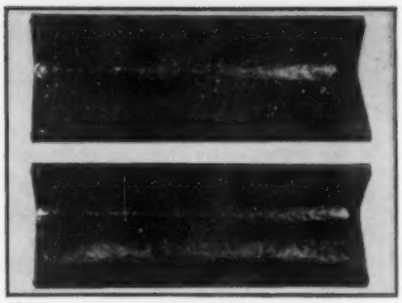
Buell W. Nutt, President

1228 St. Clair Avenue, CLEVELAND, OHIO

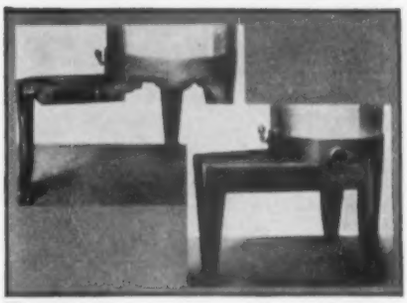
Manufacturers of a General Line of Accident-Prevention Equipment

HOW WOULD YOU WELD IT?

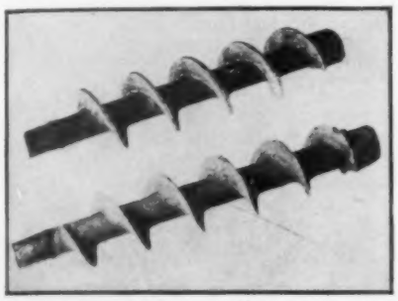
1. Arc welding boosted production of these attic ventilator frames 150%. Mild steel pipe arms are welded to cast iron feet and hub. How would you arc weld it?



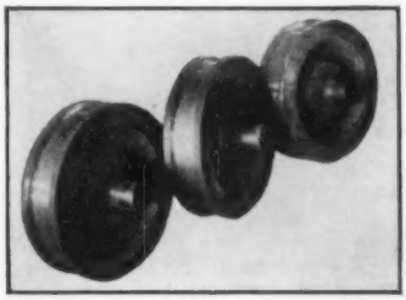
4. These specimens show how "Spatter Film" lessens the tendency of weld spatter to stick, cutting cleaning time 20% to 50%. How is "Spatter Film" used?



7. This potato peeler stand was redesigned for welded steel construction at a saving of $16.06 each. How would you start making changeovers such as this?

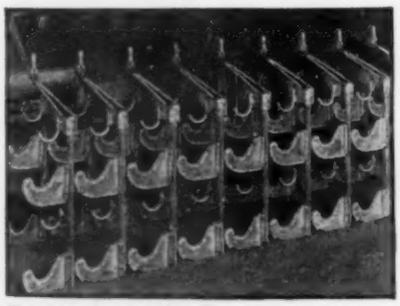


2. The face and rim of elevator stoker screw flights such as this become worn, lessening their efficiency. They can be reclaimed—made better than new. How?



5. These $140 crane wheels were reclaimed by arc welding at a saving of $110 each (including machining). Flanges were built up ½-inch. What is the procedure?

8. Four of these wheelbarrow stamping dies were reclaimed at a cost of $300 each saving $4800. What welding procedure should be used for a job like this?



3. These racks are used for storage of auto parts. Brass is used where machined surfaces rest. The remainder is steel. How would you build a structure such as this?

6. The cast iron arm of a circular shear was cracked and repaired, saving $30. How would you weld it? If the weld had to be machined how would you weld it?

9. You can get any TYPE of arc and any AMPERAGE with the new *"Shield-Arc."* How would you set it for an overhead job? It tells you right on the "Job Selector."

FOR ANSWERS, CONSULT THE NEAREST LINCOLN OFFICE OR MAIL THE COUPON

Largest Manufacturers of Arc Welding Equipment in the World

THE LINCOLN ELECTRIC COMPANY

CLEVELAND, OHIO

THE LINCOLN ELECTRIC CO., Dept. DD-579, Cleveland, O.

We now use ☐ electric arc, ☐ gas, ☐ none. Send the answer to problem number (check which) [1] [2] [3] [4] [5] [6] [7] [8] [9].

Name _____ Position _____

Company _____

Address _____

City _____ State _____

List of New Members

February 1 to February 28, 1939

BIRMINGHAM

Rodgers, Wm. (B), P. O. Box 38, Bessemer, Ala.
Ruff, Joseph Bryan (B), 903 South 21st St., Birmingham, Ala.
Tinsley, C. R. (C), U. S. Pipe & Fdry. Co., Bessemer, Ala.

BOSTON

Churchard, Chas. F. (D), 228 Salem St., Wakefield, Mass.

CANADA

Cassells, John (B), P. O. Box 4, Arvida, Que., Canada.

CANTON

De Stefano, James J. (C), 927 Wertz Ave., S. W., Canton, Ohio.

CHICAGO

Kastman, Lawrence (D), 500 Kraker Ave., Joliet, Ill.

CINCINNATI

England, William F. (D), 3958 Regent Ave., Norwood, Ohio.
Tangeman, Chas. L. (C), 3030 Guiest Ave., Cincinnati, Ohio.

CLEVELAND

Bruce, George H. (C), The Pittsburgh & Conneaut Dock Co., Conneaut, Ohio.
Maine, J. F. (C), 12003 Scottwood Ave., Cleveland, Ohio.
Shipman, Wm. H. (B), P. O. Box 242, Barberton, Ohio.
Stringham, L. K. (C), Lincoln Elec. Co., 12818 Coit Road, Cleveland, Ohio.

COLUMBUS

Dahle, F. B. (B), 505 King Ave., Columbus, Ohio.
Grant, C. O. (D), 79 N. Guilford Ave., Columbus, Ohio.
Holderby, E. O. (D), 867 Gilbert St., Columbus, Ohio.

CONNECTICUT

Gesner, Hobart E. (C), 55 Chatfield St., Derby, Conn.

DETROIT

Woodside, F. Lloyd (B), Climax Molybdenum Co. of Mich., 14410 Woodrow Wilson Ave., Detroit Mich.

GEORGIA

Donnelly, Chas. (C), % J. M. Tull Metal & Supply Co., 285 Marietta St., N. W., Atlanta, Ga.

INDIANAPOLIS

Vogel, Chas. (D), R. D. 1, Alexandria, Ind.

LOS ANGELES

Cannon, Jr., Walter B. (D), 11048 Wedding St., N. Hollywood, Calif.

MARYLAND

Bramhall, Charles H. (C), 201 Garwood St., Silver Spring, Md.
Gallagher, Chas. J. (C), 3 W. Lombard St., Baltimore, Md.
Lengerhuis, Otto (D), The John B. Adt. Co., 326 N. Holiday St., Baltimore, Md.
Sibley, R. L. (D), 1328 Weldon Ave., Baltimore, Md.

MILWAUKEE

Arbella, Edward (D), 202 E. Keefe Ave., Milwaukee, Wis.
Haslinger, Wm. (D), A. O. Smith Corp., Milwaukee, Wis.
Koresh, George (C), 4365 N. 25th, Milwaukee, Wis.
Kutuchieff, Ivan (D), 1436 N. 26th St., Milwaukee, Wis.
Rosendahl, R. C. (C), 1013 N. Chicago Ave., S. Milwaukee, Wis.
Zentgraf, Lesley (D), Crestwood Sub. Rt. 9, Milwaukee, Wis.

MONTANA

Andrews, James (C), Box 24, Sunburst, Mont.

NEW YORK

Albans, Thos. A. (D), 42 Wall St., Cranford, N. J.
Bellamy, Benjamin (C), Carnegie-Illinois Steel Co., 71 Broadway, New York, N. Y.
Humble, John S. (B), 29 W. 70th St., New York, N. Y.
McNutt, Louis C. (C), M. W. Kellogg Co., Ft. of Danforth Ave., Jersey City, N. J.
Mosley, A. Robert (D), 260 Columbia Ave., Cliffside, N. J.
Schmidt, Edward J. (D), 2001 Grove St., Brooklyn, N. Y.
Spicer, Kenneth M. (C), International Nickel Co., Inc., 67 Wall St., New York, N. Y.
Stanek, A. J. (D), 40th Ord. Co., Raritan Arsenal, Metuchen, N. J.
Urbach, L. (D), 24 Blake Ave., Brooklyn, N. Y.
Van Buren, Miles H. (B), 63 Ft. Greene Place, Brooklyn, N. Y.

NORTHERN NEW YORK

Brickley, Earl M. (D), 95 N. Allen St., Albany, N. Y.
Buckley, Chas. (D), 721 Gerling St., Schenectady, N. Y.
Forgett, Ernest (D), 37 Craig St., Watervliet, N. Y.
Van Aernem, Ralph E. (D), Ballston Spa, R. D. 3, New York.

WESTERN NEW YORK

Brass, E. W. (B), Buffalo Tank Corp., P. O. Box 16, Buffalo, N. Y.
Dial, Donald (D), Perrysburg, N. Y.
Schleich, Randall (B), Travelers Indemnity Co., Liberty Bank Bldg., Buffalo, N. Y.

NORTHWEST

Danner, W. A. (B), American Rolling Mill Co., 171—27th Ave., S. E., Minneapolis, Minn.
Paschke, George H. (D), Fuel Economy Engrg. Co., 510 New York Bldg., St. Paul, Minn.

OKLAHOMA CITY

Husky, L. D. (D), P. O. Box 463, Britton, Okla.

PEORIA

Dobson, S. W. (C), 716 N. Jefferson St., Peoria, Ill.
Greenfield, Clyde F. (D), 305 Hillyer Place, Peoria, Ill.
Pankratz, Peter G. (D), 107 Le Tourneau Court, Peoria, Ill.
Wallis, Jess (C), 201 Le Tourneau Court, Peoria, Ill.

PHILADELPHIA

Donaldson, Jos. T. (B), 1252 Maple St., Bethlehem, Pa.
Richards, Edwin J. (C), 7257 Radbourne Road, Upper Darby, Pa.
Samans, Walter (B), Sun Oil Co., 1608 Walnut St., Philadelphia, Pa.

PITTSBURGH

Reubene, Samuel (B), Independent Structural Steel Co., Vandergrift Bldg., Pittsburgh, Pa.

ROCHESTER

Cook, Willis E. (D), Bergen, N. Y.

ST. LOUIS

Fantz, Fred D. (F), 140 So. Gray, Webster Groves Branch, St. Louis, Mo.
Knachstedt, M. L. (B), Heintz Steel & Mfg. Co., 100 Clinton St., St. Louis, Mo.
Todd, Floyd (D), 4724 Winkleman Place, St. Louis, Mo.

SAN FRANCISCO

Bradbury, Leo L. (C), 536 S. Aurora St., Stockton, Calif.

TULSA

Carbon, Earl (D), Delaware, Oklahoma.
McWhirt, T. B. (D), 29 N. Yorktown, Tulsa, Okla.

WASHINGTON, D. C.

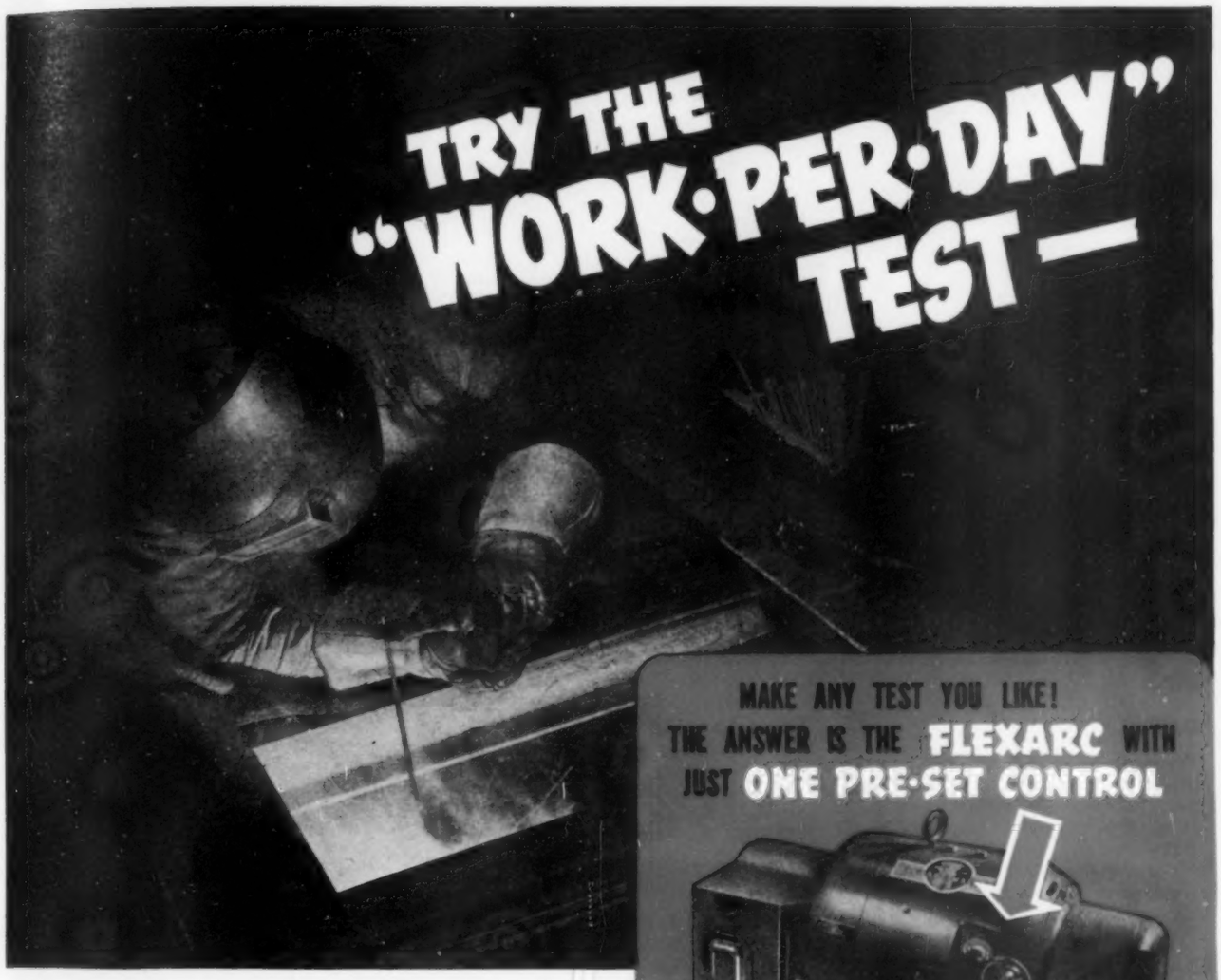
Clarke, Neil A. (C), Navy Dept., Bureau of Const. & Repair, Washington, D. C.

WICHITA

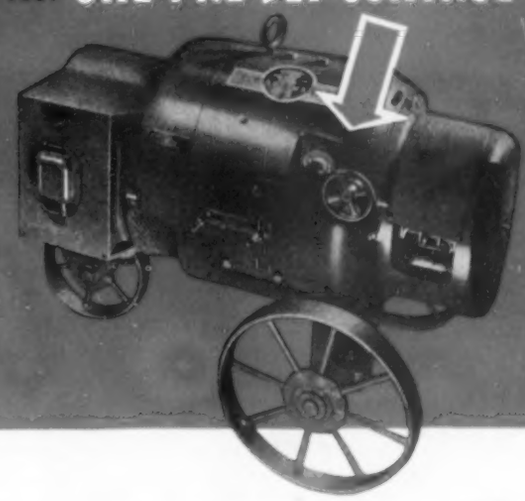
Garberson, D. D. (D), 902 Perry St., Wichita, Kans.

YOUNGSTOWN

Backus, Jr., Thomas (B), Carnegie-Illinois Steel Corp., Mechanical Dept., Youngstown, Ohio.



MAKE ANY TEST YOU LIKE!
THE ANSWER IS THE **FLEXARC** WITH
JUST **ONE PRE-SET CONTROL**



Welding claims mean little. What counts is how fast a welder actually lays down metal *on the job* . . . whether it holds a truly stable arc . . . whether it allows the operator to stay on the job and *weld*.

A "work-done-per-day" test with the FlexArc Welder gives a showdown on these facts. ONE PRE-SET CONTROL gives any current needed, *constantly*. Readjustments are eliminated . . . more welding can be done per day because the operator can stay on the job with a faster, constant arc. Test it yourself on this or any other point — but see the FLEXARC in operation before you put money into any welder!

NOW . . . YOU CAN RENT A FLEXARC WELDER!

Mail the coupon . . . Ask for details of the FlexArc rental plan. Rental applies against later purchase in full. Westinghouse Electric & Manufacturing Co., East Pittsburgh Pa. Dept. 7N. J-20813

Westinghouse Flexarc Welders

LET'S HAVE A SHOWDOWN!

☐ Please arrange a FlexArc demonstration.
☐ Send full details on FlexArc and FlexArc rental plan.

Name . . . . . .
Company . . . . . .
Address . . . . . .
City . . . . . .

Haynes, John H. (D), The Youngstown Welding & Engrg. Co., 3700 Oakwood Ave., Youngstown, Ohio.

Jeswald, Joseph (D), 41 N. Meridian Ave., Youngstown, Ohio.

Manternach, A. S. (B), American Welding & Mfg. Co., Warren, Ohio.

Mentges, Frank (D), 511 Carroll St., Youngstown, Ohio.

Nutter, Joseph T. (D), 119 Beechwood Dr., Youngstown, Ohio.

Riggle, C. R. (B), Ohio Edison Co., Ohio Edison Bldg., Youngstown, Ohio.

Smith, Alex (D), The Youngstown Welding & Engrg. Co., 3700 Oakwood Ave., Youngstown, Ohio.

Winterkamp, Frederick (B), Carnegie-Illinois Steel Corp., Engineering Dept., Youngstown, Ohio.

NOT IN SECTIONS

Bonneval, M. E. (C), Freeport Sulphur Co., Port Sulphur, La.

Cornelius, M. P., Jr., (C), 413—48th St., Moline, Ill.

Douglas, G. C. (C), Broadway Welding & Mach. Wks., 1021 W. Broadway, Spokane, Wash.

Eaton, C. D. (B), J. K. Eaton & Sons Ltd., 312 Sydney Road, Durban, South Africa.

Goetze, Herman, Jr., (D), 1702 Susquehanna St., Harrisburg, Pa.

Gumm, Eugene C. (C), R. 4, Box 254, Louisville, Ky.

Hawkins, Jesse N. (C), 1812 Eastern Pkway., Louisville, Ky.

Heudelot, C. J. (C), Science Et Industrie S. A., 29 Rue De Berri, Paris, 8, France.

Mason, Allan Shaw (B), 32 New England Road, Scottsville Mantzbrug, Natal, S. Africa.

McCormick, John B. (C), Lincoln Elec. Co., 1914 Utah Ave., Seattle, Wash.

Moore, Gladstone (D), Rt. 2, Box 199, Stoneville, N. C.

Poole, Laurence B. (C), F. A. Poole, Ltd., 560 Carl St., Pretoria, South Africa.

Revell, Jarvis J. (C), 1524 Market St., Jacksonville, Fla.

Robinson, William J. (C), Iraq Petroleum Co., P. O. Box 309, Haife, Palestine.

Smith, Cecil E. (C), 1638 Jaeger Ave., Louisville, Ky.

Wallace, H. C. (C), 6075 Taylor Blvd., Louisville, Ky.

Watt, J. R., Jr., (C), Air Reduction Sales Co., Louisville, Ky.

Wright, Louis W. (D), 2628 Virginia Ave., Louisville, Ky.

» » » SECTION ACTIVITIES « « «

BOSTON

Mr. Leon C. Bibber, Welding Engineer of the Carnegie-Illinois Steel Corp. spoke before the Boston Section on March 20th, on the subject "Impact Testing of Welding Structures." Mr. Bibber's talk was both interesting and instructive. The meeting was held at the Massachusetts Institute of Technology.

CHATTANOOGA

The Chattanooga Section held their regular meeting Friday evening, March 3rd at the Patten Hotel. About 75 members and visitors were present. The program consisted of a motion picture showing the first all-welded steel school building in New York City, and a well illustrated lecture on structural steel welding under New York City's building Code, presented by Mr. A. N. Kugler of the Air Reduction Sales Company.

CHICAGO

The regular monthly meeting of the Chicago Section was held on February 17th in the Chicago Lighting Institute. Mr. James Thomson, Chief Plant Engineer of the Continental Roll & Steel Foundry Company, addressed the meeting on the subject "Engineering Uses of Steel Castings in Welded Structures." A Get-Together Dinner preceded the meeting in The Electric Club at 6:00 P. M. A special added attraction was the presentation of "The Star Dusters," a group of six young ladies, trained for the concert stage and radio, who presented vocal interpretations.

CINCINNATI

The February meeting of the Cincinnati Section was a joint meeting of the Technical and Scientific Societies Council of Cincinnati and was addressed by Hugh H. Clegg, Assistant Director of the F. B. I., who spoke on the subject "Scientific Methods of Crime Detection."

The March meeting was addressed by Mr. H. C. Fantz of the Midwest Piping & Supply Co., whose address was on "Prefabrication of Piping Systems by Welding."

The April meeting will be addressed by Mr. W. J. Chaffee of the Hobart Brothers, who will speak on "Prefabricated Steel Housing."

The May meeting will be held in Dayton Ohio and the June meeting will be an Annual Meeting.

CLEVELAND

A very successful meeting was held on March 8th in Bingham Hall, Case School. Prof. Fred L. Plummer, now Chief Design Engineer, in the County Engineers' Office, presented an interesting talk on "Welding Design on Main Avenue Bridge."

The Cleveland Section is also giving a Spring Educational Course in Bingham Hall, Case School of Applied Science. This course started on March 10th and is being held on the 17th, 24th and 31st of March.

CONNECTICUT

The Connecticut Section was pleased to have had Mr. J. F. Lincoln, President of The Lincoln Electric Company, as their speaker on February 21st. Mr. Lincoln's unique explanation of the trend of design to the electric arc was informing and interesting. The talk was given at Yale University and was preceded by a dinner at the Yale Faculty Club.

DETROIT

The March meeting of the Detroit Section was held on the 24th in the Colonial Room, Detroit-Leland Hotel. Mr. K. L. Hansen, Consulting Engineer, Harnischfeger Corporation, was the speaker of the evening. His talk was on "The Electric Arc as a Welding Tool."

KANSAS CITY

A dinner meeting was held at the Hotel Continental on March 15th. Mr. C. W. Obert of The Linde Air Products Company, the guest speaker of the evening, spoke on "Boiler and High Pressure Vessel Welding and Codes Relating to Welding."

MARYLAND

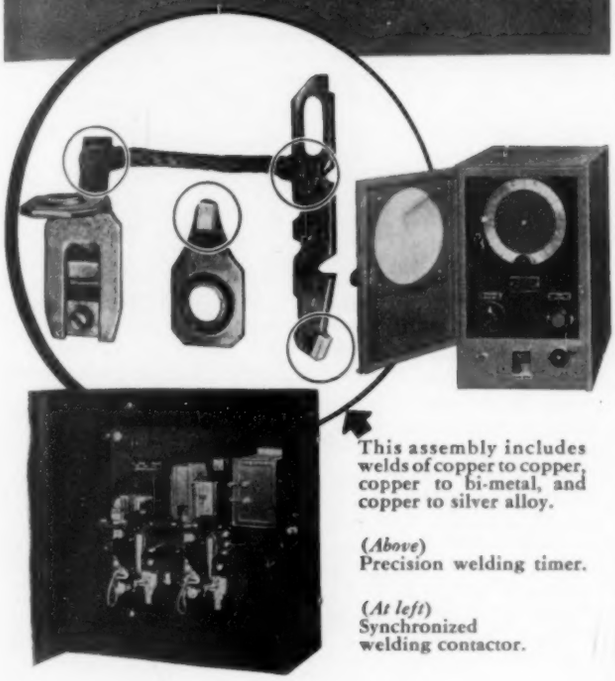
Mr. Leon C. Bibber, Welding Engineer of the Carnegie-Illinois Steel Corp., addressed the March 17th meeting of the Maryland Section, on "Impact Testing of Welded Structures." Mr. Bibber's talk was illustrated with lantern slides. Sound pictures were shown on Cor-Ten and Man-Ten. A lengthy discussion followed. There were 102 members and guests present.

The next meeting of the Section will be held on April 21st at which time Mr. Stuart Brown of Bethlehem Steel will lecture on "Welding in Residence Construction."

MILWAUKEE

A joint meeting of the Milwaukee Section of the AMERICAN WELDING SOCIETY and the Wisconsin Section of the American Society of Civil Engineers we held in the City Club of Milwaukee on Friday, February 24th. Dinner preceded the meeting. An after dinner talk was given by Dr. Paul J. Mundie, Professor of Sociology, Head of the Dept. of Social Sciences of Marquette University. Dr. Mundie's talk was on "Mental Health for Normal People." The speaker of the evening was

WELD
STAINLESS STEEL OR NON-FERROUS METALS with SQUARE D PRECISION CONTROL



This assembly includes welds of copper to copper, copper to bi-metal, and copper to silver alloy.

(Above) Precision welding timer.

(At left) Synchronized welding contactor.

● The successful welding of small metal parts—particularly stainless steel and aluminum—depends upon the very accurate control of the welding cycle. Variations in time or current wave form cause an excessive percentage of spoiled parts or imperfect welds. Heretofore, only expensive and rather intricate welding equipment has given satisfactory production.

With the new Square D precision welder control, consisting of a synchronized magnetic contactor and a new form of synchronous motor-driven timer, welding periods as short as one-half cycle are accurately obtained. A neon tube behind a revolving slotted disc gives the operator a visual check for initial adjustment and accuracy of the welding cycle.

This control can be installed on standard resistance welding machines to permit economical fabrication of small metal parts—brass, copper, aluminum, stainless steel and other metals. The investment is comparatively small. For complete details write for Precision Welding Bulletin.

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*Inside Preferred	115	105	95	85

*10% Extra for bleed full pages. Color $40 extra per color added.

Mr. L. C. Bibber, Welding Engineer, Carnegie-Illinois Steel Corp., who spoke on "Welded Joints."

NEW YORK

On Tuesday, March 7, 1939 at 7:30 P.M. the AMERICAN WELDING SOCIETY, New York Section, held a meeting on ship welding in the Engineering Societies Bldg. Mr. David Arnott, Vice-President and Chief Surveyor, American Bureau of Shipping, presided. Two very interesting papers were presented. The first was entitled "Ship Welding from the Builder's Viewpoint," by B. A. Russell, Chief of Hull Estimating & Designing Department, Federal Shipbuilding & Dry Dock Company. The second paper was entitled "Ship Welding from the Owner's Viewpoint," by William B. Jupp, Lieutenant Commander, U.S.N. (Retired), Assistant Naval Architect, Socony-Vacuum Oil Company, Incorporated. The papers supplemented each other perfectly and gave a very complete picture of the subject. Both papers were accompanied by interesting lantern slides. A great many members of the Society of Naval Architects & Marine Engineers attended the meeting by special invitation and showed great interest in the proceedings. It was indeed a pleasure to have them with us and we hope they will continue to attend our meetings on shipbuilding and other subjects of interest to them. Thanks to our numerous guests, the total attendance at the meeting was well over 500. The meeting was very successful from every point of view.

NORTHWEST

Dr. V. N. Krivobok, Professor of Metallurgy at the Carnegie Institute of Technology, and Associate Director of Research for the Allegheny Ludlum Steel Corp., spoke at the March 15th meeting on "Stainless Steel and Its Welding Characteristics." All those present were very much impressed with the discussion of such an important subject, which proved most instructive and valuable. A motion picture entitled "Welding Manipulator" produced for the United Engineering & Foundry Company, was shown, which aroused much interest.

OKLAHOMA CITY

The officers of the Oklahoma City Section have sponsored two meetings of those interested in the recent adoption of the A. S. M. E. Power Piping Code as a portion of the Oklahoma State Boiler Code.

These meetings were held in conjunction with the State Boiler Inspector, and were for the purpose of assisting him in establishing welding procedures which would be acceptable to him so that the various welderies would not be called upon to make procedure qualification tests, but by using an established and accepted procedure, the welderies would then be permitted to run their welder qualification tests. The two meetings were held so as to accommodate two different groups. The first group consisting of representatives of the State Department of Labor, under whose jurisdiction the boiler code is enforced, and suppliers of equipment and gases for acetylene welding, together with their customers and also representatives of inspection bureaus.

The second meeting was similar, except that it was given over to the suppliers and their customers in electric welding processes.

These were held on Thursday, February 17th, and Thursday, February 24th.

The regular monthly meeting of the Section was held on Tuesday evening, March 7, at the Huckins Hotel, at which time William Whaley, Assistant Sales Manager of Air Reduction Sales Company, Oklahoma City, read a paper on the subject of "Low Temperature Brazing." The paper presented many interesting features of this subject, and a lively discussion and many interesting questions followed the reading of the paper.

The Oklahoma City Section supported the Welding Conference of the University of Oklahoma, several of its members appearing on the program, others taking part in exhibiting and demonstrating materials and equipment.

The Section sponsored a meeting held on March 13th, at which time Mr. C. W. Obert, of the A. S. M. E. Boiler Code Committee and member of many of the welding committees of the AMERICAN WELDING SOCIETY, explained many of the features not only of the A. S. M. E. Code, but also the A. P. I.-A. S. M. E. Code.

This meeting was attended by representatives of the Department of Labor, the Corporation Commission, tank manufacturers, distributors of butane and propane, representatives of various insurance companies and inspection agencies, representatives of the Oklahoma City Fire Department, and others interested in the subject.

PEORIA

The regular monthly meeting of the Peoria Section was held on March 1st. Mr. A. E. Gibson, President of the Wellman Engineering Company, addressed the meeting on "The Influence of Design and Tooling on the Cost of Welded Equipment." An audience of about 100 members and guests were unanimously enthusiastic in their praise of the speaker.

PHILADELPHIA

Mr. F. H. Frankland, Chief Engineer, American Institute of Steel Construction, presented an illustrated talk at the March 20th meeting of the Philadelphia Section on "Structural Design and Welding."

A joint meeting with the American Foundrymen's Association will be held on April 17th in the Engineers' Club. Mr. C. W. Briggs, Steel Foundries Assn. of America, will speak on "Steel Casting and Plate Fabrication."

An annual inspection trip will be held in May.

PITTSBURGH

Nearly one hundred members and guests attended the lecture March 15th to hear Mr. G. S. Mikhalapov, Engineer for the Heintz Manufacturing Company, speak on "Engineering in Resistance Welding." With the use of slides Mr. Mikhalapov gave a very interesting discussion on the fundamentals of resistance welding of stainless and alloy steel, describing in much detail the methods used in this type of welding.

Arrangements are under way for the Tri-State Welding Conference to be held by the Pittsburgh Section April 28th in the William Penn Hotel. This Conference will be held jointly with the Civil Section of the Engineers Society of Western Pennsylvania and it is hoped to make it even more successful than the Conference held last year. Plans now made cover both the afternoon and evening sessions with a dinner for those who wish to meet with the speakers and guests from out of town.

ROCHESTER

Mr. Leo Edelson of Handy & Harman spoke before the March 13th meeting of the Rochester Section on "Silver Brazing Alloys." The meeting which was held in the Lower Strong Auditorium of the University of Rochester, was preceded by a dinner in Todd Union, University of Rochester. This was a joint meeting with the American Society of Metals.

SAN FRANCISCO

The regular monthly meeting was held at the Athens Athletic Club on March 24th. Mr. C. S. Smith of The Linde Air Products Company gave a talk on the subject "How Stack Cutting Speeds Production of Identical Parts." Mr. Smith's talk was illustrated with lantern slides.

SAN JOAQUIN VALLEY

Mr. Floyd Berry, representative of The Lincoln Electric Company, presented two very interesting, illustrated papers on the subjects, "Building Better Pipe Lines Faster and at Less Cost" and "Safety and Health in Arc Welding." These subjects were of particular interest to those present, since much of the activity in this Section has to do with pipe lines used in the various phases of the Oil Industry. Mr. Floyd B. Smith of the Motor Center, Bakersfield, gave additional information on this interesting subject. Following Mr. Berry and Mr. Smith, a general discussion on the subject of Welding of Boiler Flues was participated in by most of those present. Some forty-five members and guests were present and enjoyed the program.

ST. LOUIS

Mr. H. T. Pott, President, St. Louis Shipbuilding and Steel Co., addressed the March 10th meeting of the St. Louis Section, on "Arc Welding as Applied to Steel Hulls," which was illustrated.

SOUTH TEXAS

The January meeting of the South Texas Section was held on the 27th in the Tap Room of the Ben Milam Hotel,

Houston. Mr. J. F. Lincoln, President of The Lincoln Electric Company, spoke on "Welding versus Prejudice."

The March 10th meeting was held in conjunction with the International Acetylene Association meeting held in Houston. Mr. H. C. Boardman, President, Chicago Bridge & Iron Works, addressed the meeting on "Field Welded Tanks."

TULSA

Mr. Cecil Wells and Mr. O. L. Rogers have been appointed as Treasurer and Secretary, respectively, of the Tulsa Section, to fill the unexpired terms of Jay P. Walker and Richard R. Thompson, who asked to be relieved of their responsibilities because of other important matters which would not justify their continuing to serve.

WASHINGTON, D. C.

The fifth regular meeting of the Section was held on Tuesday, February 28th. The Section was addressed by Dr. J. C. Hodge, Chief Metallurgist of The Babcock & Wilcox Company, on the subject of Metallurgy of Welding. The lecture pertained particularly to the welding of pressure vessels, and was thoroughly enjoyed by every one present. There were about 65 members and guests present.

Mr. H. C. Boardman, President of the Society and Research Engineer of the Chicago Bridge and Iron Company, addressed the Washington, D.C. Section on March 28th, on the subject, "Large Welded Tanks of Cylindrical, Spherical and Spheroidal Shapes."

A regular meeting of the Section will be held on April 25th, which will be a dinner meeting. Mr. F. T. Llewellyn, Research Engineer, U. S. Steel Corporation will be the guest speaker.

A technical meeting will be held on April 12th at which Mr. I. T. Hook of The American Brass Company, will speak on "Welding Copper Base Alloys."

WESTERN NEW YORK

The February meeting of this Section was held on the 23rd in the Electric Building, Buffalo. The speaker was Dr. A. B. Kinzel, Chief Metallurgist of the Union Carbide and Carbon Research Laboratories, whose subject was "Lower Alloy Steels for Welding Applications." Dr. Kinzel's talk was highly interesting and was followed by discussion. There were 83 present. In addition to Dr. Kinzel's talk a motion picture was shown showing the operation of the Union Melt Automatic welding process. The picture as well as the talk were well received and created a great deal of interest.

WICHITA

The Wichita Section had a most successful meeting on February 24th at which were present about 75 men. The general meeting was preceded by a dinner for the Executive Committee and members which was well attended. The speaker of the evening was Mr. F. C. Hutchison, Process Manager, The Linde Air Products Company. His subject was "Flame Hardening by the Oxyacetylene Process," and was illustrated with motion pictures which were quite educational.

The art of Wood Welding was presented by Mr. J. C. Woodin of The Wichita Board of Education. The original paper revamped to meet the Section's needs proved quite interesting as well as amusing.

The following officers and Chairmen were elected at this meeting.

Chairman—L. E. Kirk, Chief Engr., Vickers Petroleum Co.

Vice-Chairman—R. L. Townsend, Sales Rep., Phillips & Easton Supply Co.

Secretary—K. O. Houser, Power Sales, Kansas Gas & Electric Co.

Treasurer—Ed Downs, Shop Supt., Ben Sibbitt Iron & Foundry Co.

Membership Chairman—J. H. Dunham, Salesman, Phillips & Easton Supply Co.

Program Chairman—R. M. Armstrong, Salesman, Machinery & Welder Corp.

Publicity Chairman—C. B. Bruer, Welding Operator, Allsteel Products Co.

Safety Chairman—O. C. Helvey, Service man, Air Reduction Sales Co.

YOUNGSTOWN

The March meeting of the Youngstown Section was held on the 7th in the Auditorium of the Edison Building. Mr. A. O. Miller presided, and the speaker for the evening was Mr. E. A. Mallett, Vice-President of the Taylor-Winfield Corporation. His subject was "Resistance Welding." The speaker's talk was illustrated with two reels of movies showing the application of spot, seam and flash welding in various industries, principally the automobile industry. The meeting was attended by approximately sixty members and guests. The Youngstown meetings have been well attended and considerable interest has been shown in Section activities.

WELDING CONFERENCE

More than four hundred people attended the Welding Conference and Exhibit held at the University of Washington, Seattle, on the afternoon and evening of Thursday, March 2nd. The Conference and Exhibit were sponsored by the Mechanical Engineering Department of the College of Engineering of the University of Washington. There were about two hundred and twenty-five, exclusive of students, present at the dinner, at which Dr. Lee Paul Sieg, President of the University presented an address of welcome.

The exhibit, which included such items as arc length monitors, straightening of steel members with the torch, flame hardening and X-ray examinations of the welds, proved to be most interesting.

The papers presented during the Conference were as follows:

Contraction, A New Method of Straightening Steel Members, by J. Holt, Welder, State Highway Dept., Seattle.

Flame Hardening, by L. N. Olberg, Sales Engineer, Air Reduction Sales Company, Seattle.

Pressure Vessels—Improvements in Their Construction, by Dr. T. M. Jasper, A. O. Smith Corp., Milwaukee, presented by S. R. Tymstra, Asst. Prof., General Engineering, University of Washington.

Welded Steel Houses, by A. A. Rock, Hobart Bros. Co., Seattle.

Shotweld Method of Fabricating Stainless Steel, by C. B. Conway, Edward G Budd Mfg. Co., Philadelphia.

Welding of Plain Carbon and Low-Alloy Steels, by Dr. W. G. Theisinger, Lukens Steel Company, Coatesville, Pa., presented by G. S. Brett, A. M. Castle & Company, Seattle.

STEEL HORIZONS

A new house publication under the title "Steel Horizons" has now appeared as a publication of the Allegheny-Ludlum Steel Corporation. It is distributed gratis to interested executives. The first issue is most handsomely illustrated in the De Luxe style. Those executives interested in the steels of today and tomorrow will find this publication most interesting indeed.

ROTARY FILES

The Grobet File Corp. of America, 3 Park Place, New York City, has added recently to its regular line of Hand Cut Rotary Files and Milled Cut Rotary Files, a complete line of Rotary Files Ground from the solid, made of super high speed

steel. These files are ground from the solid after hardening. The principal advantage of these files is that they can be re-sharpened many times at a low cost.

EMPLOYMENT SERVICE BULLETIN

POSITION VACANT

V-89. Position vacant in Turkey. This would involve teaching Descriptive Geometry and courses connected with Metallurgy. The metallurgical work will call for theoretical and practical experience in welding and heat treatment of metals. Unmarried man would receive salary of $1500 to $1800 on a three-year contract with travel allowance of $200 at beginning and end of period. In addition, would re-

ceive half of board and lodging. These items would cost candidate about $150 per school year.

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A-308. Welder with ten years' experience Electric and Acetylene Welding in shipyard, pipe lines, tanks, benzo plants and gas plants. 28 years old. Married. Willing to travel.

A-309. Welder with about ten years' experience most at the Detroit Edison Company. Welded in a railroad shop in Holland for about a year. Can do vertical and overhead welding, also can weld stainless steel nipple on boiler tubes. 32 years old. Single. Can give references.

A-310. Experienced Sales Engineer. Willing to travel anywhere. Used all phases of welding procedure and control and all classes and types of metals. Supervised men and shops.

XIII INTERNATIONAL ACETYLENE CONGRESS IN MUNICH, 1939

The XIII International Acetylene Congress that was scheduled to be held in Munich, Germany, June 25–July 1, 1939 has been postponed to Oct. 2–6, 1939, at the advice of the Permanent International Commission on Acetylene, Gas Welding and Associated Industries.

The object and purpose of the Congress are the advancement and clarification of all scientific, technical and economic questions arising in the production and use of calcium carbide, acetylene and oxygen. Corresponding to its present importance, gas welding, which includes welding, cutting, soldering, and hardening by means of the oxyacetylene flame, will occupy a special place in the technical and scientific work of the Congress. There will be a thorough discussion of the metallurgy of welding, cutting and flame hardening, as well as of methods of testing. Related branches of technology will be discussed too, especially the production of calcium cyanamide and acetylene as raw materials in chemical synthesis.

The technical and scientific work of the Congress has been divided among fifteen sections, each headed by experts. The following sections have been formed.

1. Production of carbide
2. Calcium cyanamide
3. Acetylene as initial material in organic synthesis
4. Acetylene lighting
5. Gases
6. Apparatus
7. Metallurgy of welding, cutting and flame hardening
8. Methods and applications of gas welding and cutting
9. Methods and applications of flame hardening

10*a*. Mechanical testing
10*b*. Non-destructive testing

11. Welding and cutting codes
12. Promotion
13. Safety
14. Motion pictures
15. Exposition

Experts of all countries are invited to present reports, papers and motion pictures to the Congress on new research results, practical experiences, apparatus and examples of successful applications. Those intending to present papers, reports, and films should notify the office of the Congress at Bennigsenstrasse 25, Berlin-Friedenau, Germany as soon as possible. Two typewritten copies of each report in one of four languages (German, English, French and Italian) should reach the office of the Congress by May 15, 1939. Films to be presented before the Congress also should reach the office by May 15th.

The honorary presiding officers of the Congress will be selected from representatives of the different countries at the Congress. In addition to the honorary presiding officers there will be an honorary Committee composed of representatives of interested organizations of commerce, and of science in the different countries.

The Organizing Committee of the Congress consists of representatives of the Permanent International Commission on Acetylene and of the German technical societies. The Chairmen of the Organizing Committee are Dr. Rimarski and Dr. Kessner.

The office of the Congress is at Bennigsenstrasse 25, Berlin-Friedenau, Germany.

The membership of the Congress is open to all persons, firms and organizations interested in its technical aspects. Individual members of the Congress must pay a fee of 25 marks. There is also a corporate membership involving a fee of at least 100 marks and the right to send up to four members to the Congress. A fee of 15 marks applies to ladies attending the Congress.

Official invitations to procure membership for the Congress as well as programs of the Congress were sent to the member organizations of the Permanent International Commission in different countries toward the end of January. We suggest that any one interested in the Congress should send directly or through their organization to the office of the Congress for invitations, programs and preprints.

A technical and scientific exposition will be a part of the Congress. All manufacturing methods, apparatus and products of interest to the Congress will be displayed. Advertising is not permitted at the Exposition. However the manufacture's name is stated on all exhibits. There will be no charge for exhibition room, but the exhibitor must pay freight and customs charges.

Participation in the Exposition is limited to the members of the Congress. Members who expect to have exhibits should notify the office of the Congress at once.

LEGION OF HONOR

Mr. J. E. Languepin, President of the French Society of Welding Engineers, has been made a Chevalier of the Legion of Honor of France. His nomination to the Order of the Legion of Honor is a fitting recognition of Mr. Languepin's career, which has been devoted exclusively to the development and progress of welding.

RUSSIAN CODES

1. Technical Regulations for Welding in Shipbuilding, Boiler Construction and Boiler Repair. Seventy-seven pages, published by "Vodnyi Transport" Leningrad and Moscow, 1938.

Part 1. Code for Arc Welding Steam Boilers

Part 2. Code for Arc and Gas Welded Boilers and Pressure Vessels Operating Above 7 Lb./In.²

Part 3. Code for Repairing Steam Boilers by Arc and Gas Welding

Part 4. Code for Welding Boiler Flues and Piping Systems

Three Appendices described (1) standard joints for arc and gas welding in constructing and repairing hulls and boilers (2) qualification tests, and (3) permits for responsible arc and gas welding.

2. Technical Regulations for Welding in the Repair of Naval Structures and Machinery, 27 pp., 1938, same publisher as above. The codes were approved for the Government by Chief Engineers Anderson and Sinarevsky.

LOW-ALLOY STEEL

An order issued by the German Ministry of Labor on November 11, 1938 states:

"Experience has shown that for the time being large steel structures of low-alloy steel (St 52) should not be fabricated by welding. Complete investigations are being made of the weldability of St 52 and the best conditions for welding. Considerable time will be occupied in considering the results. Until a final statement has been prepared the following rules must be observed:

1. For reasons of safety welding is not permitted on St 52 thicker than 0.79 inch in any structure requiring approval by the building authorities.

2. In any structure that has been approved in design or is in process of construction welding of low-alloy steel St 52 must not be done. Either the low-alloy steel may be riveted, or unalloyed mild steel may be substituted for welded parts."

POLISH WELDING INSTITUTE

For several years welding organizations in Poland have been planning to found a central Welding Institute. As a first step an endeavor is being made to obtain funds for a "Welding Building" in Warsaw in which all Polish welding activities will be concentrated. Under the leadership of Dr. Alfred Sznerr, the movement undoubtedly will be successful.

RULES FOR FUSION WELDING STEAM, OIL OR AIR PIPING IN MARINE CONSTRUCTION

Copies of the Rules are now available in preprint form at 25¢ per copy. Inquiries should be addressed to the AMERICAN WELDING SOCIETY, 33 West 39th Street, New York.